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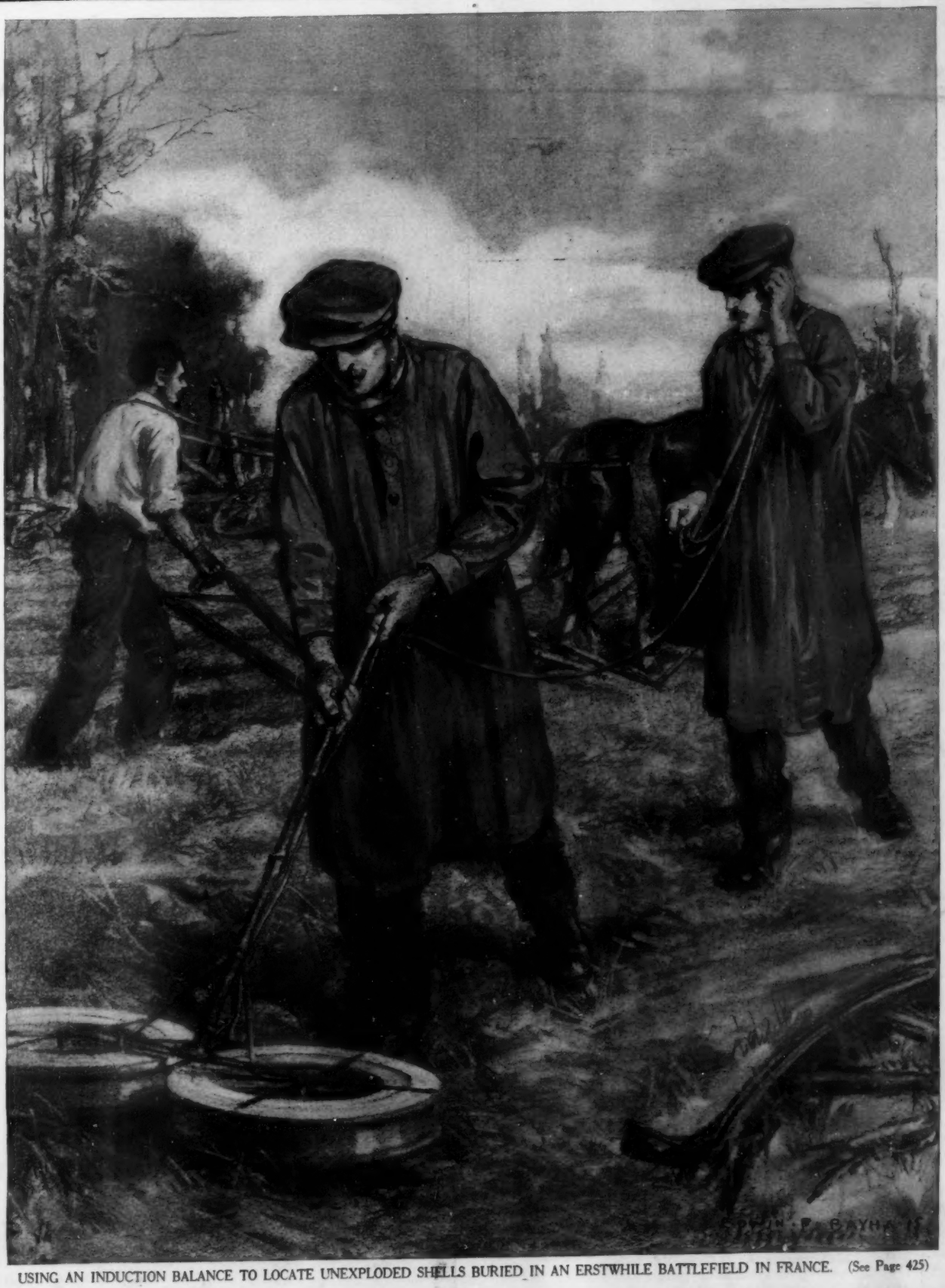

USING AN INDUCTION BALANCE TO LOCATE UNEXPLODED SHELLS BURIED IN AN ERSTWHILE BATTLEFIELD IN FRANCE. (See Page 425)

Vol. CXIII. No. 20
November 13, 1915

Munn & Co., Inc., Publishers
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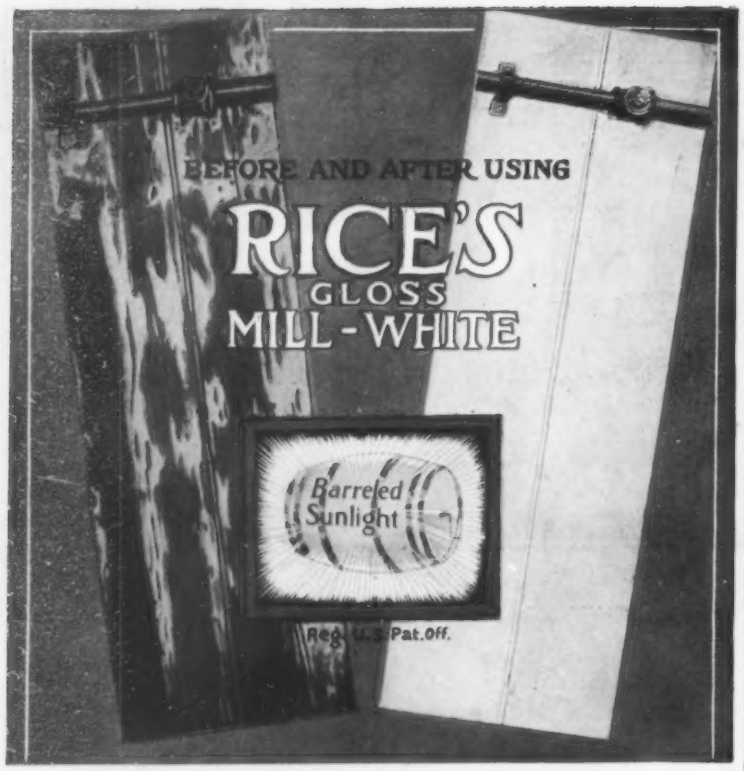

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SEVENTY-FIRST YEAR

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THE WEEKLY JOURNAL OF PRACTICAL INFORMATION

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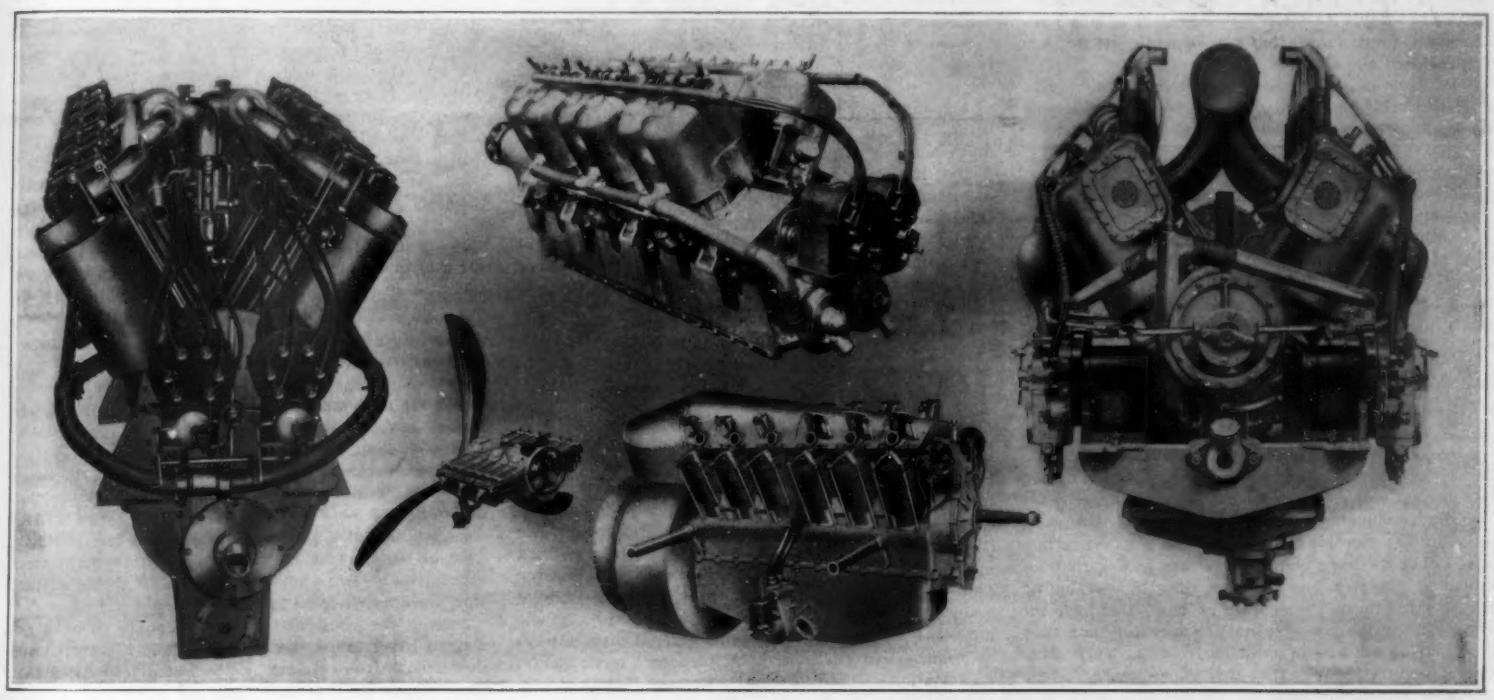

Five typical "twin-six" engines for aeroplane propulsion, representing the efforts of American, British and French constructors

From left to right: The Rausenberger engine of 150 horse-power, rotating at 1,200 r. p. m.; the Ashmusen air-cooled engine of 105 horse-power, showing the opposed cylinders; above, the Aeromarine engine of 165 horse-power, showing the double pump and magneto; below, the Renault 90 horse-power engine; and the Sunbeam 225 horse-power engine, end view

Twin-Six Engines for Aeroplanes

By Frederick Eppelsheimer

MOTORS of greater power and reliability than those now in use is the need of aviation, as expressed by the military men of every land. Constructors in the last year have been responding with the new twelve-cylinder engines of stationary type, using both water and air cooling systems; and even though it is in its very infancy, the aerial "twin-six" appears to have found a place of high usefulness in heavier-than-air flight. Among the warring powers of Europe, the governments of England and Italy are perhaps foremost in encouraging the development not only among their own manufacturers but also among those engaged in the industry in this country of the high power, reliable aeroplane engine. Even automobile builders of high reputation have been urged to undertake the production of aeroplane engines, and to date several of the best known automobile firms in England, Italy, France and the United States have complied.

Little more than twenty-four hours is the present flying record held by a German, Reinhold Boehm, who used an engine of the stationary, water-cooled type. The military aviators, however, are not seeking to break records; theirs is rather a desire to secure a motor that will never fail them, since failure often means landing behind the enemy's lines and certain capture, or perhaps even death, from the anti-aircraft fire. Beyond this, there is also the need for more and more power as the true fighting aeroplane is being developed from the experience gained in the present war. This machine must carry a load of at least a ton in men, fuel, lubricant, guns, ammunition and bombs; and for this task the 100 horse-power or less of ante bellum days has proved quite inadequate. The smaller motors are barely sufficient for the light, unarmed scout machines, let alone for the heavier machines that are being rapidly introduced; and with the ever-increasing demand for greater speed, in even the lighter machines the present motors are doomed to be abandoned in favor of the more powerful motors in the no distant future.

Economy in fuel consumption, and consequently greater radius of action as compared with rotary types, has favored the development of the stationary cylinder motor of "V" form. In the larger sizes it possesses an advantage in lighter weight and less bulk over the vertical cylinder engine. Compact in form and having a length greater than the width, the "V" engine lends itself admirably to the efficient streamline of least resistance in flight, in marked contrast to the radial cylinder engines of the stationary and rotary types. So it is not surprising to find the "V" type predominating among the new aeroplane engines of high power.

In the choice of the "twin-six" form there is evinced the effort to avoid some of the destructive elements that have made aeroplane engines unreliable. The effort in the main appears to be aimed in the right direction. For instance, vibration is responsible for a large percentage of motor troubles, and to a great extent the twelve-cylinder motor is expected to overcome this objectionable characteristic.

That the new twelve-cylinder "V" type is here to stay is the view of many authorities in the aeronautical field. Howard Huntington, secretary of the Aero Club of America, some time ago stated:

"I believe that the eight-cylinder motor will pass away in a short time and that we will have only sixes and twelves. The eight-cylinder is not so well balanced as the six or the twelve. There is more even torque in the twelve-cylinder motor. Take the centres of gravity of the moving parts in the 90-deg. "V," which is the degree necessarily used in the height, and you will find that the final center of gravity of all the pistons and connecting rods is variable. Their centers line up a little to one side of a vertical line from the crank shaft. In another position they line up a little to the other side of the vertical, all of which makes for vibration and against economy of fuel.

"When, however, the 60-deg. angle is used in the twelve-cylinder engine, no matter what position the pistons are in their centers are always in perpendicular lines to the crank shaft. This means a smoother running engine. Then, too, the 60-deg. cylinder is narrower and offers less head resistance. Using it the constructor is able to streamline the fuselage without going into undue proportions."

France led the way in the production of the twelve-cylinder type for aeroplane work even before the demand for what is now considered higher power had been voiced. Her Renault 90 horse-power engine, since increased to 100 horse-power, is well known and is much in demand at Washington, where orders for Renault motors to be used on army aeroplanes have been held up because of the European war. This motor is air cooled, using a fan blower for the purpose. The bore and stroke of the 90-140-horse-power engine are 3.78 and 5.52 inches, respectively. Its weight is 639 pounds. Its speed is 1,800 revolutions per minute, and the propeller, driven off the cam shaft, revolves at one half that speed.

Since the beginning of the war the Renault Company has taken over the Schneider automobile works at Lyons and is operating other plants at Mezieres and Billancourt, producing in all about ten motors a day for the use of the French government. It is interesting and significant to note that the smaller engines of this make have been influential in inducing the construction of larger motors of twelve cylinders, and of "V" design. Already England has two of such engines in service, America three, aside from a twelve-cylinder horizontally opposed type, and Italy at least two; while several other engines have reached a stage of construction in each of these countries.

Of the twelve-cylinder "V" type engines now in use, probably the most notable is the British Sunbeam which has been installed in a class of giant fighting biplanes at the Royal Aircraft Factory. This motor delivers 225 horse-power and weighs 1,085 pounds complete. It is water cooled. Two of these engines are used to drive one of the big tractor biplanes which have a wing spread of 70 feet. Consider 2,170 pounds of motors flying through the air by the exertion of their own power, and carrying with them perhaps twice their own weight! This engine has a speed of 2,000 revolutions per minute, which is geared down to 1,000 for the propeller.

The Rolls-Royce Company, well known as makers of automobiles, have produced on order for the British government a "twin-six" engine of 250 horse-power for aeroplane use. This engine weighs 800 pounds, and its workmanship is said to be of the most painstaking character, with much hand labor throughout; and in operation it is almost noiseless.

Aside from seeking the utmost assistance from her domestic manufacturers, England has sought the aid of American aeroplane and motor builders from the very outset of the war. One of the American-built twelve-cylinder "V" engines is to have a thorough test by the experts of the Royal Aircraft Factory at Farnborough in the immediate future. This engine is known as the Aeromarine, and is rated at 165 horse-power. Its builders have long produced a very satisfactory

(Concluded on page 434)

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The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The Editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

Missing!

IN the recent complete breakdown of the German submarine attack on merchant shipping, we witness another of those silent victories over the German Navy, of which the present war has been so fruitful. The first and greatest of these, of course, was the complete immobilization of the German High Sea Fleet, whose twenty or more dreadnoughts and battle cruisers have been shut up helplessly in German North Sea ports and in the Baltic from the very day that war was declared.

To what are we to attribute the sudden collapse of the German submarine raiding expeditions? The answer is to be found in the two fields of mechanics and psychology. We stated many months ago, when the submarines were at the height of their activities, that the experience of past naval wars justified the expectation that some effective means would be discovered for defeating the U-boat attack; and the event has proved that we were right. It is safe to say that no branch of the great naval and military operations of this war has been the subject of more thorough investigation by the scientist and the inventor than that of submarine warfare on its defensive side. Very fruitful has been the study of this problem and most efficient have been the means adopted.

Not until the history of the war comes to be written, probably, will it be known which of the defensive measures have proved to be the most successful. Probably more submarines have been accounted for by nets than by any other means; although a large number have been sunk by destroyers and swift motorboats rushing in upon and ramming them or destroying them with their rapid-fire guns. We are informed that not a few boats have been lost when they came to the surface at night to recharge their batteries. The exhaust from the oil engines is very noisy and can be heard over a great distance and, naturally, the submarines choose the night time for battery charging. The destroyers and armed motorboats gather in the submarine-infested area after night has fallen, and by careful listening detect the location of the submarines, creep upon them quietly, and then make a final dash to get them with the gun or the ram before they can submerge.

The contemplation of a lingering death in a sunken submarine may well strike terror to the stoutest heart, and the British Admiralty have made deadly use of the psychology of the situation by refraining from making any mention of the time or place of the destruction of the U-boats. When the disturbance of the floats at the top of a torpedo net showed that a submarine was entangled, the U-boat was hauled to the surface, shot full of holes and allowed to sink without a word being published of the occurrence.

The psychological effect upon the personnel of the submarine service of this absolute silence as to the fate of the submarines after they have left Wilhelmshaven or the mouth of the Elbe must be simply appalling.

So long as the fate of the U-boats which were destroyed or captured in the earlier weeks of the war was made known, the horror of uncertainty was missing; but during the past few months over half a hundred boats have failed to return. They saluted as they steamed out from their naval base, and that was the last that was seen or heard of any one of them.

Von Hindenburg has said that the present contest is one of nerves. If so, it may well be a question whether this portentous silence which has followed the passage of the U-boats upon the high seas has not been a powerful factor in breaking down the German submarine warfare.

Activity of War Inventors

NAVAL machinery for handling suggestions from civilians has been literally clogged to the breaking point since the announcement of Secretary Daniels of the formation of his naval consulting board. So fast are the ideas flowing that it is difficult to take care of them in the proper manner. The War Department seems to face a similar problem. The War Department used to receive on the average about 200 inventions a year from civilians, who believed they had a new idea in some death-dealing machine, but now these have increased to about that number a week, according to estimates, with a range and variety of subjects corresponding to numerical product. It has become a serious problem, it is said, to handle these inventions in a way which would give little occasion for complaint, the impression prevailing evidently that on account of Secretary Daniels' inventions board some new assurance exists for the favorable consideration or adoption of all sorts of inventions. Many of the communications, too, are impatient protests against the delay in action or remonstrances against the failure to accept suggestions.

Some of the inventions received by the army relate to the protection against the use of gas in attacks, and the devices are of all grades of usefulness and degrees of ingenuity, from a simple cloth covering for the face to an elaborate structure to be worn on the shoulders and composed of rubber tubing. Another favorite object of invention seems to be the periscope, consisting of arrangements of mirrors, which will permit a view of any enemy without the exposure of the observer to fire. Another subject of interest appears to be the hand grenade. Then again there are a number of propositions how to protect battleships against destruction from torpedo attacks.

Two Points of View

IN a controversy many words are wasted, much heated argument goes for nothing, because the two sides base their reasoning on different assumptions. This is an old sin, and one with which everybody is perfectly familiar. It is also a sin which nearly everybody frequently commits. In all the innumerable articles and books which have been written for or against Germany since the war started, there is scarcely one clear statement of the fundamental assumptions which are made, on the one hand, by Germany, and, on the other hand, by her opponents. Yet these two sets of assumptions are perfectly definite, and there is all the difference in the world between them. It must always be remembered that Germany possesses a wonderful organization and that a wonderful organization means, among other things, willing subordination. Thorough organization, on the German plan, is not practicable in a country where the coal-miners, every now and then, go on strike in the midst of a fight for existence, and where a union of labor leaders acquaints the government that they have decided to disobey certain orders should they be issued. We are not now discussing the merits of this procedure; we are merely pointing out that it is incompatible with the spirit which permits complete national organization.

But the psychological consequences of these two national tempers result in just that difference in outlook and assumptions that we set out to explain. Owing to the German's ever-present consciousness, whether he be soldier, merchant, inventor or what not, that he is a unit in a great machine, that he definitely fits in, that his activities are not random and uncoördinated activities, he acquires an enormously developed consciousness of the *state*. More than any other people the Germans realize that they form part of a great state. Putting the matter briefly and therefore with some overemphasis, we may say that to an Englishman England is the country he lives *in*, while to a German Germany is the country he lives *for*. The aggressive patriotism of the German abroad has all the vigor of a religious devotee defending his faith. For by now the German's devotion to his country has changed almost to a worship of the state. Like other worshippers, he must have an idol, so he has invented an abstraction. It is a compound of all German virtues and aspirations, and it is called Deutschland. In conversation with Germans, it is a little difficult to get at the precise significance they attach to this concept labeled Deutschland. It does not mean merely the Germany of the present; in some way it includes the Germany of the future—all that Germany is and all that it is going to be.

Now this conception leads to a code of morality which differs from that of practically every other nation. It gives the German a different set of moral assumptions. It is frequently said that certain German methods of warfare are dishonorable. But granting the German point of view, it is plainly impossible to add to the wealth, importance and power of Germany by dishonorable means; for any action which adds to the wealth, power and importance of Germany is thereby honorable. The end entirely justifies the means; for by the proposed end are the means judged. The philosophy is not new, but the scale on which it is practised is new. The opponents of Germany merely have a different philosophy. They believe that there are certain root principles of conduct, well expressed in a certain famous American document, to which not only individuals but also nations are subject. This belief is very general, except in Germany. To the Germans all rules of morality are subject to the requirements of the state. The German is not, as some of his more frantic opponents have asserted, a conscienceless devil, or an inhuman fiend. He is merely a worshipper of a new deity, whose name is Deutschland. Being ardent and thorough, he is willing to violate anybody else's code of morality in the defense and extension of his own. A man's actions must be judged by their motives. It is therefore irrelevant for the opponents of Germany to call the German wicked, although they may fairly describe him as, from their point of view, objectionable. A system of belief which exalts Germany above all the world and which only concedes to other nations a right to exist in so far as they directly or indirectly minister to the power and glory of Germany, might seem, to a keen observer, to have traces of egotism about it. To those who compare the scientific and artistic achievements of Germany with, say, those of France, it might even appear ridiculous. But its believers are no lukewarm lip-servers, and they testify to their belief in blood and iron.

The Tsar of all the Russias has proclaimed a holy war. The French, English and Italians all conceive themselves as fighting for the root principles of civilization. Germany fights for Deutschland. This war is very largely idealistic. Besides fighting for territory, the control of the sea, and such like plain and material things, each man, at heart a mystic, is also fighting for his God.

Economic Value of the Detroit River Tunnel

THERE are usually to be found on trunk lines with a fluctuating volume of traffic one or more points which, for physical reasons, limit the amount of business which may be handled economically upon the whole line. When the traffic approaches the maximum, congestion is found in these points, the whole line becomes affected, and operating costs rise abnormally. Such a point was found at the Detroit River Ferry, over which the through traffic of the Michigan Central had to pass, and as early as 1870 plans were studied both for a tunnel and a bridge, which at that time were found to be impracticable.

During the construction of the double tube of the Detroit River tunnel the work was fully illustrated and described in the columns of the SCIENTIFIC AMERICAN. The tunnel and the fine terminal station in Detroit have both been completed, and the new system has been sufficiently long in operation to enable the relative cost of the old ferry system across the river and the new transit by way of the tunnel to be determined.

Up to the year 1910 all Michigan Central trains were ferried across the river. This caused the breaking up of through trains and involved many switching movements, to say nothing of a delay of from three to eight hours per train in through freight service. On account of the swift current, the heavy steamship traffic through the channel, the difficulties of fog in summer and autumn, and the ice in winter, it was found impossible to maintain schedules or to regulate traffic in a satisfactory manner. This condition was especially noticeable in relation to perishable freight, which had to be given precedence over all other classes, with the result that great quantities of ordinary kinds of freight were greatly delayed; and there was a constant and heavy expense for demurrage on empty cars, which were the last to be cleared, and the detention of these latter caused a constant congestion in the yards.

Since the opening of the tunnel the average time of passenger trains between Windsor, in Canada, and the new Detroit terminal is about nine minutes, which is less time than it formerly required to place the trains on the transfer boat. The average time for moving a freight train through the tunnel is about 20 minutes, as compared with several hours required for breaking up, switching, reassembling and ferrying trains under the former method of operation.

The particulars of this work and its economical advantages will be found in the current issue of the SUPPLEMENT, and it is sufficient here to state that the growth in average monthly operating revenues since the opening of the tunnel is from $2,046,311 to $2,547,361, an increase of 24.49 per cent. Although much of the increased traffic represents the normal growth, there is no question that the large traffic is due to the better service which the road can now render.

As to the economical advantage, it is sufficient to state that although the investment in the tunnel property and equipment is about eight times as large as that required for the transfer boats and slips, the cost of switching and operating trains and maintaining the property is so much lower that the higher interest charges and taxes are more than offset. The construction of the large station at Detroit, the more convenient arrangement of the tracks, and the moving of the switching yard to the Canadian side, have contributed to the convenience both of the large shippers of merchandise and the general traveling public.

Notes on the War

British Submarines in the Baltic.—Very serious, coming as it does when Germany is feeling the pinch of the British and French blockade, are the activities of British submarines in the Baltic, which have resulted in the sinking of a large number of ships carrying supplies to Germany; for it is mainly through the Baltic Sea that the Central Powers have been able to import necessities for the combatants and noncombatants within their borders. Unless Germany practices those methods of defense that have been employed so successfully by her adversaries, the submarine menace may grow to a point at which it will effectively close German Baltic ports to merchant shipping.

The Chain-Shot Principle in Shrapnel.—A new shrapnel shell, the invention of Capt. T. Wiener, an American resident abroad, affords one more instance during this war of the application of old-time methods to present conditions. In the new shell, by a simple device, the strands of the bullets are welded to steel wire, and on the bursting of the shell, it is given, what the inventor terms, a "circular rotative movement" in its onward flight. It would seem that the new device should prove effective in breaking down barbed-wire entanglements, a work which hitherto has been done chiefly by high explosive shells.

German Submarines and Their Work.—The well known naval writer, Archibald Hurd, considers that the German submarines are really torpedo boats capable of submerging. They are now as large as some scout cruisers displacing 1,000 tons or more, having an armament of a similar character and using the gun as well as the torpedo. The vessels which have been employed in the sinking of unarmed merchant-ships at sight, are not submarines at all, but submersible cruisers. Because they are capable, as ordinary cruisers are not, of diving under the water at will, the Germans claim that they can set aside the laws of naval warfare relating to search and capture as applied to ordinary cruisers, and that they are justified in setting up a new code marked by ruthless outrage.

The Monotony of Blockade.—From the above-quoted authority we gather that Admiral Beatty, who won the North Sea battle-cruiser fight, said in a recent speech: "More than a year ago we started this war in the Navy with a hoot of joy. . . . We thought we were going out to follow in the footsteps of the heroes of one hundred years ago; but what has been the result? We have barged about the North Sea, missing mines and dodging submarines, and our patrol vessels have kept our harbors intact." To this "Fore and Aft" replies "That at the outbreak of war with France in 1803, Nelson was appointed Commander-in-Chief in the Mediterranean, but he had to wait nearly two and a half years before coming to real grips with the enemy at sea. Then, as now, it lay with the enemy to decide if and when he would leave his harbors and make a fight of it."

The Unheralded Work of the Navy.—Writing in the *Naval and Military Record*, "Fore and Aft" refers to the unheralded work of the Navy, and asks why some paper does not tell the country, every morning, what the Navy is doing—thus "Monday, the Navy has enabled us to purchase abroad $60,000,000 worth of ammunition"—"Tuesday, thanks to the Navy, we are keeping our men at the front well supplied with stores and equipment of all descriptions and are more than making good the wastage among them"—"Wednesday, 1,300 ships arrived in British ports with food, raw materials, and munitions of war—thanks to the Navy." "Thursday, an enemy submarine was sighted off ——— yesterday, but no one will sight it any more—thanks to the Navy"—"Friday, there are scores of thousands of army-trained Germans in neutral countries who cannot return home to fight—thanks to the Navy."

The French to Build Battle Cruisers.—The French Naval authorities, like those of the United States, have not hitherto favored the construction of battle cruisers; but the fine performance of these vessels under Beatty in the North Sea and under Sturdee at the Falkland Islands has aroused the French Admiralty to a sense of the wisdom of building some ships of this type. A displacement of 30,000 tons is suggested, and, because of the fine results shown in the test of the new French long-calibre 13.4-inch gun, it is probable that the battle cruisers will be armed with this piece, which will be supplied with a somewhat heavier shell. Another reason given for holding to an existing type of gun is the time which would necessarily be lost in building a new type gun and experimenting with it. On the other hand, it should be remembered that the 15-inch gun of the British Navy was built, accepted and shipped abroad without being tested. Nevertheless, it has proved to be a most excellent weapon.

Science

The Satellites of Mars were repeatedly seen with the 32¾-inch refractor at Meudon at the last opposition. Phobos, the nearest, is much brighter than Deimos. They both seem to shine with a bluish light; probably an effect of contrast with the ruddy color of the planet.

Messina, the Sicilian city that was destroyed by an earthquake, with enormous loss of life, in 1908, is rapidly rising from its ruins, and it is interesting to learn from a recent consular report that the new city is being constructed entirely of reinforced concrete, a style of construction which has proved its ability to withstand severe shocks of earthquake.

Julius Payer, the leader of the Austro-Hungarian expedition of 1872-74, which discovered Franz Josef Land, died August 31st. His son, Julius Payer, organized in 1913 a French expedition to explore the same region, and planned an extensive use of aeroplanes in that connection. The expedition spent the winter of 1913-14 at Vardö, Norway, but nothing has been reported in regard to it recently.

Evaporation in the United States.—The Weather Bureau has recently undertaken a campaign for the determination, under standard conditions of exposure, the relative values of evaporation in various parts of the United States, and, if possible, the relation of these values to other climatic factors. It is planned to equip about thirty stations with instruments of identical pattern. The Bureau is also preparing to publish the results of its previous elaborate observations of evaporation, at Salton Sea and elsewhere.

The Sanitation of Swimming Pools is discussed in a recent number of the *Public Health Reports* by Dr. W. A. Manheimer, of Columbia University. The author calls attention to the many diseases that are spread by insanitary pools and reviews the methods of sanitation heretofore suggested. The results of his own analyses of the water in a number of pools, under various conditions, show that a combination of the methods of refiltration and chemical disinfection gives the most effective sanitation. Anhydrous chlorine appears to be the best disinfectant.

Samples for Grading Rosin.—In connection with the naval stores investigations carried out by the U. S. Bureau of Chemistry, durable, accurate and practical type samples for grading rosin at the still have been made of colored glass, and sets of these samples have been deposited with various trade bodies. Hereafter they will be sold at cost to anybody desiring them. These samples have been adopted as official by all organizations having control of naval stores in this country, and also recognized by law in the state of Florida.

Antidote for Snake Bite.—According to the handbook on British India just published by the U. S. Bureau of Foreign and Domestic Commerce, good results have attended the efforts recently made in India to prepare antidotes against the bites of certain species of poisonous snake that have caused great mortality in that country. At Parel Laboratory, Bombay, venom from live cobras is injected into horses in gradually increasing doses for a period of two years, until the animal acquires immunity to the poison, and, according to the familiar principle of serum therapy, the serum of the immunized horse constitutes an antivenin, which is said to be an infallible cure for cobra bite if injected promptly enough into the patient. This laboratory also prepares an antivenin against the bite of the Russell's viper, but has not yet produced any against that of the krait (*Bungarus*) or *Echis carinata*. During the twenty-five years ending 1911, more than half a million human beings were killed by snakes in India.

The Handbook of India, recently issued by the Department of Commerce, is a unique compilation of facts relating to industrial and commercial conditions in British India, Ceylon, Afghanistan and Tibet, filling some 640 octavo pages. Although primarily intended for the guidance of American merchants and manufacturers, it is a geographical work of general interest, as it throws a flood of light upon many features of Indian life concerning which little has heretofore been written. Here one learns, for example, that cast-off uniforms of every kind are immensely popular in Afghanistan; that the natives of India have acquired the habit of giving Christmas presents, particularly of the edible variety; that in the native state of Baroda cinematograph shows are used for the industrial and agricultural education of the people; and thousands of other facts more or less beyond the range of ordinary descriptive works on India. Although the book contains contributions from a number of consular officers, the bulk of it was written by Mr. Henry D. Baker, and is an amplification of the admirable series of articles recently contributed by that official to the Daily Consular and Trade Reports.

Aeronautics

Launching of New York Naval Militia's First Hydro-aeroplane recently took place in New York city. The craft was presented to the Naval Militia by Henry A. Wise Wood, vice-president of the Aero Club of America, on behalf of Glenn H. Curtiss and the National Aeroplane Fund. The hydro-aeroplane is of the type used by the United States Navy, and is driven by a 100-horse-power motor.

Santos-Dumont and the Zeppelins in War.—Alberto Santos-Dumont, one of the pioneers in both lighter-than-air and heavier-than-air flight, during a recent interview stated that in his opinion the Zeppelins had proved a failure from a military point of view, since they had not succeeded in inflicting damage on fortified works or in gaining definite military advantages for their users. In marked contrast, he stated, the aeroplane had shown itself to be an effective weapon of war.

Flashlight Signalling from Aircraft.—There has been perfected in the United States an electric flashlight intended for signalling from an airship. The device is small and light, and its flashes can be read at a distance of from six to eight miles in daylight when the sun is shining. Obviously, the signalling range is even greater at night. The shutter mechanism is simple and rugged, and with it a speed of from 20 to 30 words per minute can be attained by a skilled telegraph operator. Current for the electric bulb is supplied either from storage cells or from a generator driven by the airship motor.

Transatlantic Liner as Mother Ship for Seaplanes.—The well-known American war correspondent and writer, Frederick Palmer, in writing of his recent visit to the British Grand Fleet makes the following statement: "The seaplanes which were sailing over the fleet had their home on a famous Atlantic liner, which has carried many thousands of passengers." The earlier practice of detailing several seaplanes to each warship has evidently been abandoned in favor of a single and central mother ship especially equipped for taking care of these craft. In the Dardanelles operations a mother ship has been used since the beginning, the "Royal Ark," which has been especially equipped for its task.

Increased Range of Anti-Aircraft Artillery.—The past fifteen months of war in Europe has resulted in a remarkable advance in anti-aircraft artillery. Whereas, at the beginning of the conflict, the aviators considered themselves secure when flying at altitudes of 8,000 feet, since the shrapnel burst some thousands of feet below them, there is attendant danger to-day even when flying at 10,000 feet. The range of the anti-aircraft guns has been steadily increased from below 5,000 feet to over 10,000. It is becoming increasingly difficult for aeroplane observers to conduct effective reconnoissances owing to the great height at which they are compelled to fly over enemy positions.

Important Improvements in English Practice.—The British Advisory Committee for Aeronautics reports great progress in many directions in the development of aeroplanes. Investigations in relation to stability have led to definite improvements in ease of handling, without loss of speed. Entirely new designs have been evolved. Tests of these show that, without sacrifice of controllability, it is possible to make the aeroplane inherently stable, and capable of flying satisfactorily without the use of the controls. In developing these machines, alterations were introduced in every portion and feature. New types of machines have been produced, embodying special features that military experience has shown to be desirable. Wireless and other methods of signalling have been studied, as well as gear by which bombs can be dropped with accuracy. Considerable improvement has also been made in motors, which are being produced by several manufacturers.

Huge French Triplanes for Offensive Operations.—The ante bellum military aeroplanes having been found inadequate for the carrying out of raids on an extensive and successful scale, the French have since the opening of the war been developing a type of giant aeroplane especially suited for carrying heavy bombs and suitable ordnance. The new type is in the form of a triplane, and is known as "l'avion de bombardment." It has a wing spread of some 70 odd feet, and the three superposed planes rise to a height of 20 feet. The nacelle of the giant triplane will comfortably hold twelve men, although the crew is ordinarily composed of but six men, viz., two pilots, who sit close together in the centre of the car, two observers and two gunners. One pilot can operate the machine in an emergency. The triplane carries four 37 mm. (one and one half inch) guns. Although no mention is made of the horse-power of the engine or engines required to propel the new aeroplane, it is safe to assume that it must be in the neighborhood of 300 or more horse-power, probably divided among two or three engines, since the aircraft is credited with a speed in excess of 80 miles per hour.

The United States Dreadnought "Nevada"

THE latest dreadnought of the United States Navy to be completed and go through her trials is the "Nevada," which is here shown steaming down the East River, New York, on her way to have her acceptance trials over the Government measured mile course, in which she steamed at over 21 knots.

The "Nevada" possesses several distinctive features which, taken together, are sufficient to render her a type ship, marking a new era in our battleship construction. In the first place she mounts the 3-gun turret—a new type in our Navy, which has also been installed on several of the latest ships of foreign navies. The second innovation is the unusual thickness and wide distribution of the heavy armor on this ship; nothing approaching it can be found on any other dreadnought of contemporary design and construction. The third notable feature is that the ship uses oil fuel, all of the boilers being oil-fired and no coal whatever being carried for the motive power of the ship.

The main battery of the "Nevada" consists of ten 14-inch guns, six of which are mounted in two 3-gun turrets, one forward and one aft; the other four being carried in two 2-gun turrets, the latter mounted of such a height that their guns can fire across the roofs of the adjoining 3-gun turrets. The torpedo-defense battery consists of twenty-one 5-inch guns mounted on the main and berth decks. This ship also carries four submerged 21-inch torpedo tubes.

The guns of the 3-gun turrets are mounted in a common sleeve, and, consequently, they are rotated in the horizontal plane and elevated as one gun. To prevent the blast at the muzzles of the guns interfering with the true flight of the projectiles, matters are so arranged that the center gun of the three is fired a small fraction of a second after the outer two. In addition to the saving of weight in the 3-gun turret, there is the advantage that spotting the fall of the shot is simplified, the observation for one shot being good for all three.

The "Nevada" and her sister, the "Oklahoma," are the most heavily armored ships afloat to-day. They carry a belt which is 13½ inches thick amidships and is 17½ feet wide, 8½ feet of the belt being below the load water line. The barbettes are protected by 13 inches of armor and the turret armor is from 9 to 18 inches thick on the triple turret and 9 to 16 inches thick on the double turret. A valuable feature is the protection of the base of the single smokestack by inclined armor which extends from the gun deck to the forecastle deck. The conning tower is also protected by 16 inches of armor.

The great beam of the ship and the fact that no space is taken up in the wings by coal bunkers, make it possible to group the whole of the boiler equipment amidships and lead all the uptakes to one large smokestack. The batteries of boilers, as so assembled, are grouped in several separate apartments formed by running transverse and longitudinal bulkheads throughout the boiler spans.

The "Nevada" is driven by Curtis Turbines, the sister ship "Oklahoma" being furnished with triple-expansion, reciprocating engines. The fuel tanks are capable of carrying 2,000 tons of oil. The normal displacement of the "Nevada" is 27,500 tons and the full load displacement 28,400; the complement of officers and men is 863.

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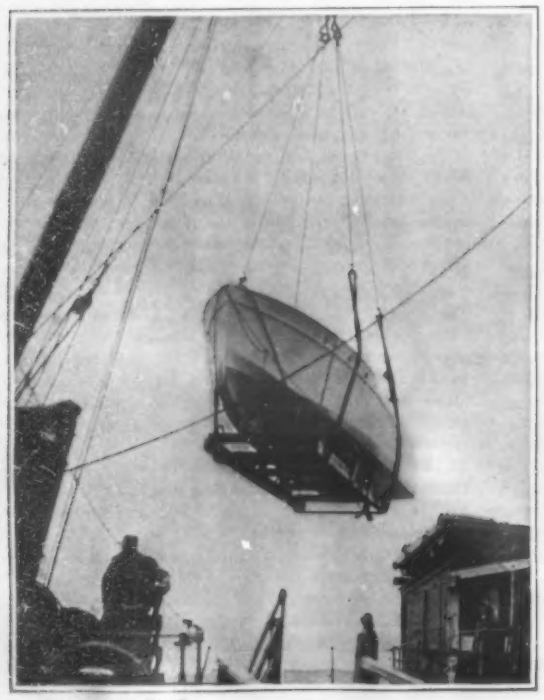
Our latest dreadnought "Nevada"

Tonnage, 27,500. *Speed*, 20.5 knots. *Fuel*, 2,000 tons, oil. *Armor*, belt, 13½"; turrets, 18". *Guns*, ten 14", twenty-one 5". *Torpedo Tubes*, four 21". *Complement*, 863.

"Submarine Chasers" for the British Navy

AMONG the many defensive methods which have been adopted by the British Admiralty against the German submarine attacks on merchant shipping was the creation of a large fleet of small motorboats, each armed with a rapid-fire gun. These crafts were distributed methodically over the areas which were known to be infested with submarines, or along the routes by which they approached and left their hunting grounds, and the moment they sighted a periscope or the hull of the submarine as she approached the surface, they made a swift dash for her and opened fire with the hope of penetrating or breaking off the periscope, or better yet, holing the hull of the vessel itself.

This mosquito fleet was built very rapidly—orders being widely distributed. Our illustrations show three of the "submarine chasers," part of an order of forty, which were built at Lawley's yard, Boston, which have been shipped to England for use in guarding the coasts of Great Britain. There were six in the first shipment. All of these craft are named after various fish of the sea. They are 100 horse-power, gasoline launches of uniform design, capable of making twenty-five knots. The contracts were awarded last Spring, and it is stated that they cost $4,000 each. They have a strongly-built deck forward, for the purpose of mounting a rapid-fire gun, probably of three inches, and below is a commodious trunk cabin containing accommodations for two or three men. They are of the V-bottom type, and the motors are equipped with a special carbureting device, by means of which either gasoline or a heavy oil may be used.



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Hoisting one of the craft aboard for shipment to England

Three of the fast motor boats, known as "submarine chasers," built for running down submarines and sinking them by gun-fire

Enlarged view of bat's hair

Enlarged view of a bat's skull

Anatomy of the ear of a bat, greatly enlarged

Malarial Mosquitoes as the Food of Bats

Experiments and Observations Indicating That the Bat Is the Arch Enemy of the Malarial Mosquito

By Chas. H. R. Campbell, M. D.

THAT the services of the usually despised little creature, the bat, can be enlisted in combating the malarial mosquito has been conclusively proved by the experiments conducted at Mitchell's Lake, a most notorious malarial locality some ten miles from San Antonio, Texas. In this lake flows all the sewage of that city, some 10,000,000 gallons daily, and in the past it has been the breeding place for millions of mosquitoes. To-day, however, the locality is entirely free from mosquito-conveyed disease, thanks to the mosquito-devouring bats that have been encouraged to make their homes in especially constructed bat roosts.

As far as the author has been able to ascertain, the bat is the only animal that hunts its food through the sense of hearing, although it will follow a large moth around an electric light for some few seconds, as if employing sight and smell, before devouring it. A great many nocturnal insects are provided by Nature with acrid or even blistering fluids for their protection, and how the bat in its rapid flight avoids these insects is, the writer believes, accounted for by the fact that the bat will attack only such insects as emit certain tones in their flight; and it is through the tones so made by the vibrations of the insect's wings that the bat distinguishes the species best suited for its food. As a result of many observations along these lines, it has been found that insects emitting a tone lower than C natural, first ledger line below the staff (International pitch 435), are avoided by bats. The tones emitted by mosquitoes range from staff D, to F, G and even higher.

The aforementioned observations were made under an electric arc light around which hovered innumerable insects attracted by the light, as well as a number of bats attracted by the presence of the smaller winged creatures. With an insect net the author caught a number of these insects which, it had been previously observed, the bats were rejecting; also a large number of mosquitoes and other insects of the species which the bats were devouring. In the case of the rejected insects, on causing them to fly in the net the tones emitted were invariably lower than C natural; while for the accepted insects, which, by a large per cent, were mosquitoes, the tone ranged from C sharp (staff) to F or G. The sudden dips, dashes and dives the bat makes through space also support this observation, for these sudden dashes, entirely out of its range of vision, could only be induced by its hearing some favorite insect in that locality. Another convincing proof of this assertion, and one which is in entire accordance with the foregoing, is that the flight of the bat is noiseless. The accompanying enlarged photograph of a bat's ear shows the anatomy of that organ to correspond with our knowledge of the physics of sound, because the cartilagenous concentric ridges correspond to the spherical sound waves, while the cartilagenous conical projections placed on the edge of the ear are to break the sound waves, should they pass above the cartilagenous ridges.

That Nature always gives a creature protection from its enemies in some form or another, is a matter of common knowledge. Accordingly, if the bat is the arch enemy of the mosquito, surely this insect must have some method of protecting itself against that creature. Just what form of protection the mosquito resorts to is readily reasoned out: the mosquito must stop its flight to protect itself, for it is by the vibrations of its wings that the characteristic sound waves are produced, attracting the bat's attention. In order to prove this line of thought, the author made an experiment which places this point out of theory and into fact.

A small back room, 10 feet long, 5 feet wide and 5½ feet high, was thoroughly cleaned, canvassed and white-washed. The room has one small window to the east and a door to the west, which were thoroughly screened with fine wire mesh. Tens of thousands of mosquito eggs were procured and placed in a tub of cistern water to which there was previously added some organic matter to furnish food to the larvæ. In the course of time, thousands of mosquitoes hatched out, and these were fed by placing two turkeys and two old fat hens in the room until all the mosquitoes hatched out.

At night, after the mosquitoes had developed into adult insects, the buzzing noise could be plainly heard several feet from the room. On one occasion the writer entered the room with a darkened electric flash light and liberated two bats. Instantly the buzzing noise ceased, and on turning on the light it was observed that the mosquitoes were clinging to the walls and motionless. On taking the bats out of the room, in less than three minutes the buzzing noise was resumed. This experiment was afterwards repeated several times with the same results.

Bat roost erected at Mitchell's Lake, near San Antonio, Texas, April 2nd, 1911

That bats have a selective instinct for finding the engorged mosquito is furnished by the testimony that chemistry furnishes, namely, that hemoglobin contains 0.42 of 1 per cent of iron, and blood contains 15 per cent of hemoglobin.[1]

One ton (2,000) pounds of bat guano contains three pounds of iron. Three pounds of iron is the ferric content of 4,761 pounds of blood. Sixty-seven per cent of bat guano consists of chitin, and this (chitin *per se*) contains 85-100 pounds of iron, which is the ferric content of 1,349 pounds of blood. The remaining 33 per cent contains 2 15-100 pounds of iron, which is the ferric content of 3,412 pounds of blood. To be very conservative and avoid all possible source of error, let us deduct 15-100 pounds of iron, representing 237 pounds of blood, as being derived from plant-sucking insects which carry chlorophyl. This, then, would leave two pounds of iron, representing 3,174 pounds of liquid blood. Such quantity would make every pound of bat guano represent more than one and one half pounds of liquid blood. It must also be considered that the female mosquito in the process of biting, and after she is at rest digesting the meal, voids the liquid portion of the blood (*liquor sanguinis*) in order to concentrate her food, which, of course, does not figure in the chemical determination of the iron content in the guano. Imagine the millions of engorged mosquitoes that the bat must catch to make each pound of guano represent more than one and one half pounds of liquid blood!

[1] From text books.

The character and arrangement of the teeth of bats show them to be distinctly carnivorous, and the mosquito with its abdomen engorged with blood furnishes that creature with an ideal carnivorous diet.

A remarkable defence with which the bat is provided is a very singular one, being its protection against its principal food, the malarial mosquito. This protection is accomplished by means of the peculiar formation of the hair covering the bat's body. The hair is not a round shaft like ordinary hair, but instead consists of lances and pockets, and is similar in form to a number of morning glory flowers strung on a straw, with the edges of the flowers terminating in points and with the bells outward. It is evident that if the hair were a round shaft it would not afford the protection as do the peculiar lances and pockets in preventing the mosquito's proboscis from reaching the bat's skin. This, the writer believes, is a very important observation, inasmuch as it entirely harmonizes with the habits of bats and mosquitoes inhabiting dark places during the day. It is a well-known fact that the female mosquito cannot oviposit without albuminous food, and in obedience to the inexorable laws of Nature this insect would resort to the bat to obtain this albuminous food, and possibly transmit to the bat the disease the mosquito conveys.

Detecting Buried Shells with Induction Balance

WHEN the erstwhile battlefields of Europe are reclaimed for the peaceful purposes of agriculture, there is an ever-present risk of death or serious injury to both the farmers and their horses as the result of plowshares coming in contact with buried shells that have failed to explode when fired.

The danger from unexploded shells buried in fields is regarded as particularly grave in certain parts of France. Recently, an engineer was commissioned to devise a method for the discovery and subsequent removal of such shells. His report on the matter was laid before the French Academy of Sciences at their session of July 5th; an account of his findings appearing in the *Comptes Rendus* of the Academy for July 26th.

The instrument that has been devised by the French for the detection of buried shells is an adaptation of the Hughes induction balance. The original instrument was made by C. Gutton at the request of the prefect of the Department of Meurthe-et-Moselle, and with it the constructor was able to detect the presence of a small calibre shell at a depth of about 40 centimeters (nearly 16 inches). The apparatus, which was thoroughly tested, is so sensitive that its user can detect by the sounds in the head telephones the proximity of a mere scrap of shell on or near the surface of the ground, or even a tin can. The note sounded by a shell fragment differs from that caused by a buried shell,

(Concluded on page 434)

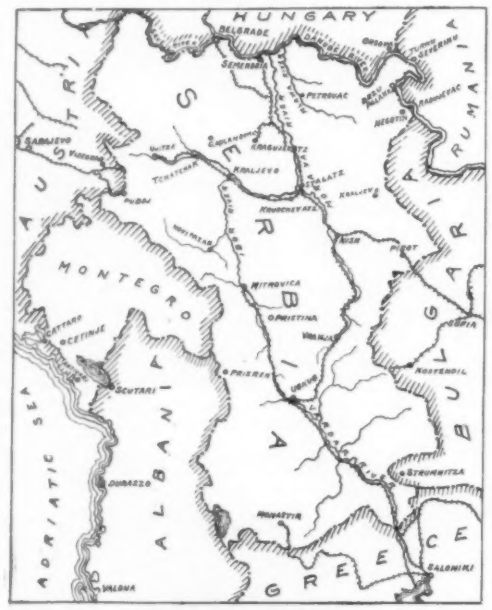
Strategic Moves of the War, November 4th, 1915

By Lieut. J. B. W. Gardiner, Formerly of the 11th Cavalry, U. S. A.

THE center of military activity still rests in Serbia. There is no longer the slightest doubt that Nish, and with it the control of the Oriental railroad, from Berlin to Constantinople, must fall into the hands of the Teutons. The German rate of advance along the Save and Danube front was at first exceedingly slow. Just why this was is more or less a matter of conjecture. There is certainly nothing in the character of the country of northern Serbia that would tend to make military operations. For some distance east and west of Belgrade the country to the south is fairly open and gently rolling, rising, of course, as one goes towards the mountains. East of Belgrade, in the vicinity of Semendria, the country is more open, and more flat than the Belgrade country, containing the valleys of the Mlava and Morava Rivers. During the first ten days or two weeks of the Teuton invasion, Mackensen was able to advance only about eight miles into Serbian territory. There are certain known factors that were responsible for this low rate of advance of less than a mile a day, and others which are not definitely known but which in all probability were at least contributory causes of the known factors. The two that stand out are the preparation of the Serbians, which having had ample warning were beyond doubt thorough, and the fact that the entire advance of the Teutons depends largely on their superiority in heavy guns, and, although they have proven to be remarkably efficient in blazing the way for the advancing infantry, yet take considerable time to move forward. Of the probable causes, one was numbers. Anticipating an attack along the Save-Danube line, by far the greater part of the Serbian army was naturally concentrated for the defense of that front. Germany had not over 200,000 men at the outset, and these were drawn at the expense of the front in Russia and eastern Galicia. Reinforcements could not be obtained as the Russians were too active, particularly on the Strypa front in Galicia, to permit a further weakening of that line. Therefore, the advance was held up to enable the activity of Bulgaria to draw from the northern line a portion of the Serbs, who were opposing the Teuton advance. Still another probable factor was the quality of the men in the Teuton ranks. It would be remarkable indeed if the men the Teutons detached from other fronts for the Serbian campaign were the equals, as fighting units, of the men engaged in the prior campaigns either in Russia or in the west. The terrific losses which the Teutons have sustained during the last few months have naturally been heaviest among the first line troops, thus lowering the quality of the troops which are now found bearing the brunt of the fighting. Even, however, if the rate of the advance from the north was at the outset slow, the Teutons were playing a game, the outcome of which was absolutely certain. The Bulgarians opposed as they were by greatly inferior forces were bound either to drive the Serbians on their front rapidly westward or force a redistribution of the Serbian forces so as to reduce the number defending the northern approaches. The latter evidently occurred, probably in the hope that at least a delay might be effected, during which the reinforcements which were promised by the Allies would have a chance to land and come to the Serbian defense.

But the delay has not been very great and the reinforcements not in sufficient numbers to stem the advance. Nish seems doomed. There were really two objectives in the Teuton-Bulgarian scheme of things. One was the boot-shaped corner of Serbia, which lies between Hungary, Rumania and Bulgaria, and the other, the Belgrade-Sofia railroad. The former gave the water route to Constantinople by way of the Danube, and to secure it it was necessary for the invaders to occupy completely and thoroughly the northeast corner. This was effected by the advancing Bulgars capturing Negotin and effecting a junction with the Teutons west of that place. The other objective was, of course, Nish and the railroad to Sofia. Once the Danube was opened, the advance from both the north and east became much more rapid. One line after another fell to the Teutons, among the captures being the arsenal town of Kraguyevatz, with a considerable quantity of military supplies. At this writing, they have advanced to Cacak on the railroad from Ujitze to Kruschewatz, which joins the Belgrade-Nish road about forty miles north of Nish. On the east the Bulgarians have not advanced with the same rapidity that has marked the Teuton advance of the past ten days because of the absence of heavy artillery, and because, also, of the mountains that screen eastern Serbia from the Bulgarian border; at the same time their advance has been steady and consistent and they are closing in surely from every railroad on the Nish junction. Every branch road leaving the Nish-Belgrade road north of Nish itself is, therefore, now in the hands of the Teuton allies. There is, therefore, grave danger of the Serbian army in the north being completely enveloped and forced to surrender or else to retreat southward overland, abandoning much of their artillery and transport. Immediate retreat would appear now an absolute necessity if the army is to be saved. Its safety would seem to depend to a large extent on the strength of their positions along the Ibor valley, which runs through some of the densest hills of central Serbia. If a line on either side of this valley can be held there is still a possibility of effecting a junction with the Allies by means of the railroad from Uskub up the Ibor valley to Kraljevo.

In discussing railroads in connection with the transportation of troops, however, it might be well to make plain just what the moving of large numbers of men, with the necessary equipment, means, from a railroad standpoint. European trains are not as heavy as those we often see in America. The engines are not as heavy, nor do they have the same traction power. The cars are lighter and smaller and their capacity much less. The rails are also lighter, and the time made much less than that made by our trains. Figuring on the European standard an army corps of 40,000 men, with its full complement of horses, guns, ammunition, baggage, field kitchens, etc., requires about a hundred and fifty



The Serbian battlefield

trains. French statistics show that the French roads move on the average, 325 men to a train, so that the estimate of a hundred and fifty for an army corps cannot be far wrong. On the French main line during mobilization, the plans allowed for a train every ten minutes for 20 hours out of 24. To accomplish this, there were required, at least, several thoroughly equipped stations with ample siding accommodations, loading appliances, etc., at both ends of the route. Except for the main Belgrade-Sofia line all the lines in Serbia are light, single-tracked. Suitable stations, particularly in the mountain districts (and the Uskub-Kraljevo line is all in the mountains), are few and far between, and siding accommodations leave much to be desired. Rolling stock is none too plentiful. Indeed, it is doubtful if enough vehicles and engines could be obtained to move one army corps up this valley—and one army corps would be but a temporary stop gap—and not enough to place a serious check on the Teutons. Even with the ideal military system of Germany, where there are parallel lines over which the traffic can be distributed, the most that the Germans have been able to move from one front to the other at one time, has been a single army corps, and this has taken from a week to ten days to accomplish. Too much reliance cannot, therefore, be placed on the fact that according to a map, two points, at one of which troops are stationed, and at the other these troops are needed, are connected by a railroad here. There is hope that the northern Serbian army may find help and respite along the Ibor valley—but the hope is slender. Nish must fall and with its fall the situation of the Serbians is truly desperate. In southern Serbia the situation is somewhat confused by lack of definite reports from any of the capitals. The Allies—principally the French—are believed to be present in considerable force, and as far as is known, hold the Saloniki railroad from the Greek frontier to Uskub. There has been no fighting of importance since the first battle in front of Strumnitza some days ago. The Allies and their plans are, of course, the great unknown factor. They seem to have been taken completely unawares by the combined action of the Teutons and Bulgars, and, as far as any practical results obtained thus far are concerned, give no evidence of having yet recovered from their first surprise. In a recent speech before the House of Commons, Lord Asquith endeavored to excuse his government's failure to send aid to Serbia more promptly on the ground that the British had been counting on the assistance of the Greeks, and had no idea that Greece would not comply with the terms of her treaty with Serbia the moment the invasion started. Consequently, when Greece refused to assist in the Serbian defense, England was not prepared on such short notice to land sufficient troops to prevent the invasion. This, while it might satisfy the British people and act as a balm to their conscience, cannot be taken seriously by anyone not infected with the British germ of conceit. If British diplomats really felt sure of Greece and so advised their government, British diplomacy has become more impotent even than is Germany's. But it is inconceivable that this was really the belief of the British Foreign Office. The attitude of the Greek King was as well known in London as in America. And every student in this country, of the Balkan situation, had from the outset expressed skepticism as to participation in the war by the Greek Government. The British simply shirked their responsibilities just as they did in the case of Belgium at the beginning of the war, and, also, just as they were then, are absolutely panic stricken at the result. The outcome of it all now is that the Teutons have already opened a water route to Constaninople, and in a short time will open also a rail route. This means the inevitable failure of the Gallipoli campaign. Whether the British are broad enough to acknowledge that for the present, at least, they must admit defeat is another question. Something of British pride and prestige must suffer if the British army has to yield to the great defensive strength of the Turks, but the situation will soon arise, if, indeed, it has not arisen already, and it does not seem so, where the forces on the Peninsula will be in desperate straits through additional supplies sent the Turks from Germany, and then a withdrawal will be effected only with terrible losses. It would seem much the better policy to place the Gallipoli forces where they can do some good commensurate with their losses—in Serbia, for example—only 24 hours away. A covering force of 150,000 men could be left behind, and as they would only need to act on the defensive, could, with the aid of the fleet hold the Turks in check. This would release 100,000 men for service in Serbia, where they are badly needed. But the British are slow to think and more slow to act, and before they decide to make any move the German submarines, shipped in parts to Constantinople, will be operating in the Black Sea against Russian transports and harassing the Allies in the Aegean when landing at Saloniki.

Serious as the Serbian campaign appears to be, however, it is still not apparent how it is vital to anyone except Serbia. Serbia is threatened not with defeat but with annihilation. In its effect on the outcome of the war, it is an episode—startling, dramatic, but in no sense, decisive. When Germany succeeds in conquering Serbia from the Danube to Nish, throws open the gates of Constantinople to German troops and supplies, what then? Will an invasion of Egypt or of India follow? There is not the slightest chance. Germany has not the men to send. Neither the Russian nor the French front will stand weakening without serious danger, and as her opponents on both of these fronts have shown a willingness to attack at the slightest opportunity, the present line must be kept intact without further depletion. But England is too close to the trouble to get a true perspective, and the mere thought of danger to Suez has destroyed British equilibrium.

The Teutons, however, are not invading Serbia for pleasure—and their probable object is not hard to find. Germany wants peace, and from many quarters come rumors—all German in their origin—of a covert campaign among neutral monarchs to this end. Every German writer, from Bernhardi up and down has predicted Germany's fall in just such a contingency as that now existing, unless Germany can, by eliminating completely one of her opponents, break up the coalition against her. Germany's commerce is gone, her reserves in men, money and shell fast going. One last successful blow—delivered with all the strength and thoroughness that marked the invasion of Belgium, and admirably handled by an efficient corps of press agents, and the Allies might be willing to listen to peace proposals coming from a neutral state.

The Dyestuff Famine.—II

The Promise for the Future

By Prof. Thomas H. Norton, Ph.D., Sc.D., Bureau of Foreign and Domestic Commerce, Washington

[In last week's issue of the SCIENTIFIC AMERICAN *Prof. Norton outlined the salient factors in the current struggle to meet the pinch of the dyestuff famine; now he is taking up the prospects of establishing a well developed dye industry in this country.*—ED.]

WHAT is being done to lay the foundations of a genuine, comprehensive self-contained, American coal-tar chemical industry; one which will free the country ere long from all economic dependence on foreign sources for the element of color as needed by our vast textile and allied interests?

In reply, I may state that amidst all the great haste to meet pressing and insistent demands, with the enlargement of existing plants and the erection of new plants, there is every evidence of thrift and economy. This augurs well for a complete absence of unnecessary overhead charges, as the scope of the industry broadens.

As a rule, the firms now engaged in the production of intermediates, contemplate the manufacture later of finished dyes. Mr. Edison, who has done such magnificent work in this field by his rapid organization of the production on an extensive scale of synthetic carbolic acid and of aniline, does not plan to continue the output of the latter after the close of the current war. With this exception, all of the numerous firms now occupied with the manufacture of coal-tar compounds are planning to continue their production along the lines already taken up, and to enlarge such production, or enter upon the manufacture of additional intermediates or finished dyes, as circumstances dictate.

Quite recently capital has been enlisted to an unusual extent in the development of the dyestuff industry. The past month has witnessed the incorporation of a company, with an authorized capital of $15,000,000. The plans of this company are of a broad and generous character, covering plants in several states. It will probably prove to be an important factor in the evolution of the industry.

Another company, with an authorized capital of $2,000,000, entered recently upon the active manufacture of dyestuffs in its large factory at Cannel City, Kentucky.

Several smaller companies, lately incorporated for active work in this field, reveal a wide-spread tendency on the part of many investors to enter vigorously upon a campaign to build up the dyestuff industry.

There is quite noticeable an evident effort on the part of some ardent chemists to further the movement by attempting the introduction of hitherto unknown organic dyes, produced apparently by relatively simple chemical reactions, some from coal products, others from petroleum waste.

Such attempts are regarded with a benevolent eye, as are all other efforts made intelligently and earnestly to limit the strain of the dyestuff shortage.

Time must elapse before careful and exhaustive testing shows the permanent value of these new dyes as regards cost of production and actual tinctorial properties.

Possibly some of the new colors, of entirely unknown composition, may possess enough tinctorial value to warrant their use during the period of a distinct color famine. No prophecies can be made as to the permanent value when brought into keen competition with highly perfected coal-tar dyes.

Favoring Conditions

The conditions favoring the establishment of a permanent, comprehensive, American coal-tar chemical industry are as follows:

The United States possesses all the needed raw materials in abundance, in such amount that it could meet the demands of the world's dyestuff industry. It offers the largest existing market for the consumption of dyestuffs.

Enterprise, inventive talent, and technical ability are present to an almost unlimited extent.

The time is eminently propitious for the establishment of a national industry. All indications point to the continuance for a year or two of conditions—most deplorable in themselves—which favor a period of construction, free from the disturbing element of foreign competition. Capital is ready to embark in the new field in ample amount, and is daily being invested.

It demands simply that measure of statutory protection against unfair competition on the part of foreign rivals which we now have every reason to hope for, since the policy of the national government in this connection has been outlined so forcibly and so emphatically.

It is most refreshing to note the utter indifference to minor side issues manifested by the men who are determined to build up this new industry. But a few years ago discussion would have centered about the tariff. To-day the men who are ready to finance a color industry, or to throw into it the best of brain and nerve, are asking simply for a fair show—laws to prevent a competitor from hitting below the belt.

This marked readiness of capital to now embark generously upon the new field, this willingness even to establish upon our soil the manufacture of a coal-tar derivative, such as synthetic indigo, without a cent of protection, do they not tell the whole story?

Can we not but admire the energy and determination of the men who stand at the head of the large works in Buffalo and Brooklyn, of Edison in Orange, and the other younger members of the group, who are so bravely, so wisely, so skillfully, engaged in laying the foundations of our coming American coal-tar chemical industry?

Possible Swiss Coöperation

There is possibly one factor lacking to bring rapidly into existence a comprehensive American coal-tar dyestuff industry. That is the coöperation of a few men possessing highly developed capacity for organization, combined with a perfect experimental command of the exceedingly complex and intricate field of color chemistry in all its ramifications—men such as created in the past the great works on and near the Rhine, and are now directing them.

I have thought that it might be possible to secure such needed coöperation from the large and well equipped staffs of the four color works at Basel, in Switzerland.

These highly specialized staffs include scores of men of broad experience in the manufacture of the whole range of coal-tar dyes. Most of these have enjoyed in earlier days the advantages of the "Polytechnic" of Zürich, one of the best equipped institutions in Europe for the training of color chemists. Many have served a more or less extended apprenticeship in the gigantic German chemical works.

It is not difficult to imagine a union of forces in this field, a consolidation of interests between the Swiss companies and the American firms now striving to expand, but forced, as it were, to grope in the dark at times. The transfer of a sufficient corps of Swiss expert color chemists to the United States at this critical moment would be of untold value in furthering the rapid evolution of the American industry.

It would be possible, by their aid and direction, to attain, as regards time and money, the maximum of economy, in constructing new plants, in adopting the most practical and effective mechanical devices, in applying the most economical methods, in coordinating the diversified features of a complicated branch of manufacture, so as to avoid loss of material and restrict the dependence upon highly skilled and expensive labor. At every step in the organization of new plant, and in the initial months of its operation, directive coöperation of practical experts would insure the establishment of a self-contained, coal-tar color industry on American soil, with a minimum of outlay and a maximum of efficiency, in the shortest possible period of time. It would probably enable the industry, in its broader phases, to become so thoroughly rooted in the economic life of the country that, upon the return of normal international exchanges, legitimate competition of foreign rivals could be easily and effectually met.

How Swiss Chemists Are Solving the Russian Problem

A striking example of how the dyestuff problem of a great nation can be solved by the cooperation of Swiss intelligence and experience is now seen in Russia. The textile and allied interests of the Russian Empire depended chiefly upon Germany for color materials. The largest dyestuff company of Germany conducted a branch factory in Russia prior to the war. Dependence upon Germany for semi-manufactured material, and for finished dyes, was quite as pronounced as in our own country or in Great Britain.

The sudden interruption in current supplies of dyes, consequent upon the outbreak of hostilities, was a heavy blow to Russian textile works. A way out has been found by the organization of a strong company, of which the leading dyestuff house of Basel is a constituent member. This latter furnishes an administrative and technical staff—in other words, the "brains" of the undertaking. Capital is supplied by a group of prominent Russian textile manufacturers, who at the same time are the chief consumers of the dyes produced.

The arrangement is eminently practical. As in the recent British organization, the consumers of dyestuffs are the owners and controllers of the undertaking, and a continued market for the output is assured. An abundant source of crude material is furnished by the Russian coke works. The requisite factories have been erected at a considerable distance from the present line of military operations.

What has been done so easily and simply in Russia to meet present emergencies and lay the foundation for a future national dyestuff industry, can serve admirably as an object lesson to the United States, ordinarily so much more prompt in recognizing industrial opportunities.

The creation of a comprehensive manufacturing plant by an alliance between Swiss experience, enterprise, and skill on one side, and the large financial resources under the control of our great textile interests on the other side, is a solution by no means difficult of realization. It would assure capital, management, and market, the three essential factors to success.

A less complex, and perhaps more feasible method of accomplishing the end in view, would be found in establishing a comparatively close organic connection between individual Swiss companies and individual American companies already engaged in the active manufacture of dyestuffs, but limited hitherto to a very narrow range of products.

It is well to note in this connection the relations of the Swiss color industry to both the American and the international markets.

The average annual value of the Swiss exports of artificial colors to the United States during the five years ending June 30th, 1914, was $815,911, as follows: Alizarin and alizarin colors, $1,777; synthetic indigo, $48,904; other coal-tar colors, $765,230; total, $815,911.

In 1913-14, Switzerland supplied seven per cent of our imports of indigo and 10.6 per cent of the imports of aniline dyes. The import of alizarin was insignificant.

Since the outbreak of the war, and the resultant scarcity of artificial colors, the Swiss import has been of great assistance to American textile interests.

The normal production of the Swiss dyestuff works available for export purposes has an annual value of about $5,500,000. It is equivalent to one ninth of the German export, and could cover alone neary 60 per cent of the average annual imports into the United States of artificial colors.

Few realize the rôle which Switzerland has played in the evolution of the artificial dyestuff industry, despite the entire absence in the land of coal and of raw material for the manufacture of chemicals, with the exception of salt. Immediately prior to the war, Switzerland, on the basis of population, was supplying twice as much as Germany to the world's market for synthetic colors!

Correspondence is now under way, which may lead to a more or less close coöperation between the dyestuff interests of the two republics.

There are several other phases in the evolution of an American color industry which deserve careful attention at the present time.

Necessity of Unity

The first is connected with the somewhat rapid entrance into this field of a number of separate interests, imperfectly acquainted with the complexity of the problem.

It is well known to every one who has studied the fundamental basis of the past dominance of German color chemistry in the world's markets, that the chief cause of this marvelous control lies in the solidarity of the German industry as a whole.

It is so organized that all the correlated parts act in unison. They form practically a unit when, in any land, a serious effort is exerted to secure freedom from dependence upon foreign sources of color.

The question now arises: Is it not eminently desirable that a comprehensive, American coal-tar industry, striving to supply nearly all American tinctorial needs, with products made from American raw materials, should possess a higher degree of unity,—financial, technical, commercial,—than now is the case? Is it not of prime importance that all unnecessary overlapping, and duplicating of effort be excluded, at least in the formative stage?

The problem is more easily stated than solved. It is economically important, during the initial period, that the industry should be characterized by that unity and solidarity which contribute so largely to the might and effectiveness of the German rival; and yet it must be free from any tendency towards monopolistic power.

I must content myself with simply expressing an aspiration, a hope, for economic conditions which may powerfully aid a young industry in bravely holding its own.

(*Continued on page* 433)

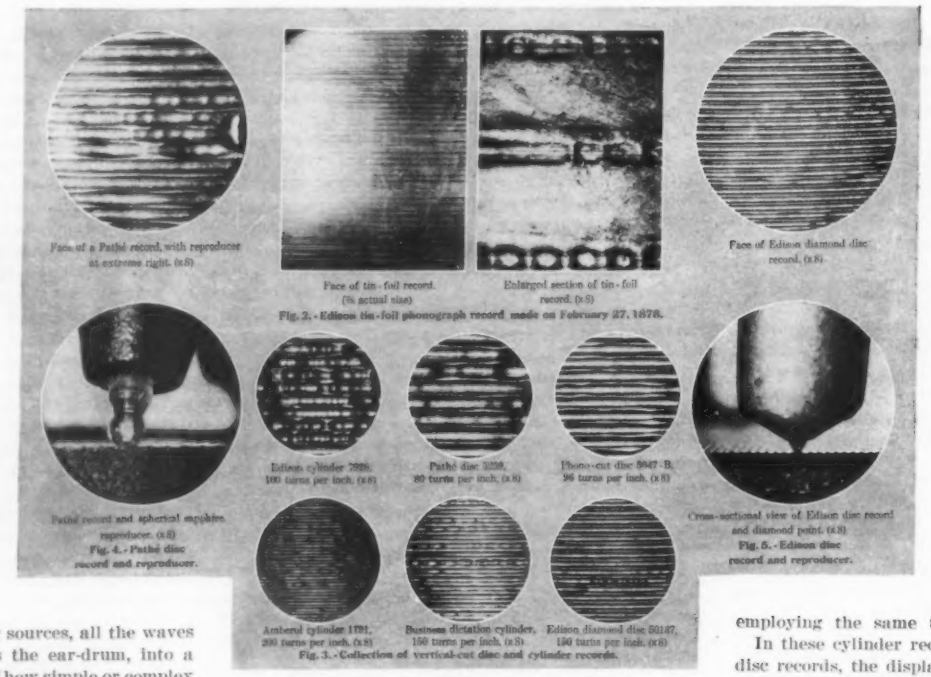
Microscopic Study of the Phonograph

Discussion of the Mechanical Features of Record Grooves and Styluses

By J. B. Taylor

TWO of the most remarkable and widespread inventions, the telephone and the phonograph, were scientific novelties less than 40 years ago. Besides being nearly of the same age, they have much in common. Both depend fundamentally on the same extremely simple principle, and appreciation of this inherent simplicity may be regarded as the real invention in both cases. The construction of properly working apparatus certainly required genius and inventive ability of a high order, but of a different nature.

All speech and all music are simple from a mechanical standpoint and therefore capable of well-nigh perfect transmission by telephone, or of nearly perfect recording, preserving and reproducing by phonograph. However complex, elaborate or multiplied may be the sound-producing sources, all the waves combine at any surface, such as the ear-drum, into a single wave. Now, irrespective of how simple or complex this wave may be, the drum or diaphragm, which moves back and forth following the motion and pressure of the air against it, cannot occupy two positions at the same time. In other words, if it were possible to write down the extent of the stretching of the ear-drum (and whether in or out) at intervals of, say, 1-10,000 second, and make the table long enough to show all these values for a whole second or a minute, it would be practicable to record and analyze, as it were, any sound. Obviously, some apparatus is needed to measure the stretching or deflection of the membrane; and since the impossibility of taking down figures so rapidly is evident, an automatic recording of the diaphragm deflection is necessary. As an artificial diaphragm of suitable size and material construction will follow sound waves in the same manner as the ear-drum, continuous records can be made with the aid of a light stylus or needle attached to a diaphragm fitted with multiplying levers and bearing on a smoked glass or paper surface which is moved along at a uniform rate under the recording needle. With no sound the diaphragm is at rest and the needle draws a straight or "zero" line. Deflections caused by sounds produce a wavy or irregular line. (See Fig. 1.).


Face of a Pathé record, with reproducer at extreme right. (x8)
Face of tin-foil record. (⅝ actual size)
Enlarged section of tin-foil record. (x8)
Face of Edison diamond disc record. (x8)
Fig. 2.-Edison tin-foil phonograph record made on February 27, 1878.
Pathé record and spherical sapphire reproducer. (x8)
Fig. 4.-Pathé disc record and reproducer.
Edison cylinder 2926. 100 turns per inch. (x8)
Pathé disc 5259. 80 turns per inch. (x8)
Phono-cut disc 5047-B. 96 turns per inch. (x8)
Cross-sectional view of Edison disc record and diamond point. (x8)
Fig. 5.-Edison disc record and reproducer.
Amberol cylinder 1791. 200 turns per inch. (x8)
Business dictation cylinder. 160 turns per inch. (x8)
Edison diamond disc 50147. 130 turns per inch. (x8)
Fig. 3.-Collection of vertical-cut disc and cylinder records.

Types of up-and-down cut grooves and styluses

Such an apparatus, the phonautograph was constructed and records made years before the telephone or phonograph was introduced. Probably most of the phonautograph records were far from accurate sound records, since such factors as size, weight and tension of diaphragm, natural frequency of vibration, damping

Fig. 1.—Typical records of sound waves made with a phonautograph

of vibrating parts and serious distortions due to resonance of collecting horn or chamber were not recognized. Some modern apparatus for analyzing sound employs in place of the tracing stylus a light mirror which reflects and deflects a beam of light focussed to a small spot on a moving photographic plate or film.

Having obtained the sound record, whether by means of smoked glass, photographically or otherwise, any device,—many have been constructed and many more suggested,—which will control the compression or rarefaction of the air to correspond with the record will reproduce the original sounds and constitute a phonograph.

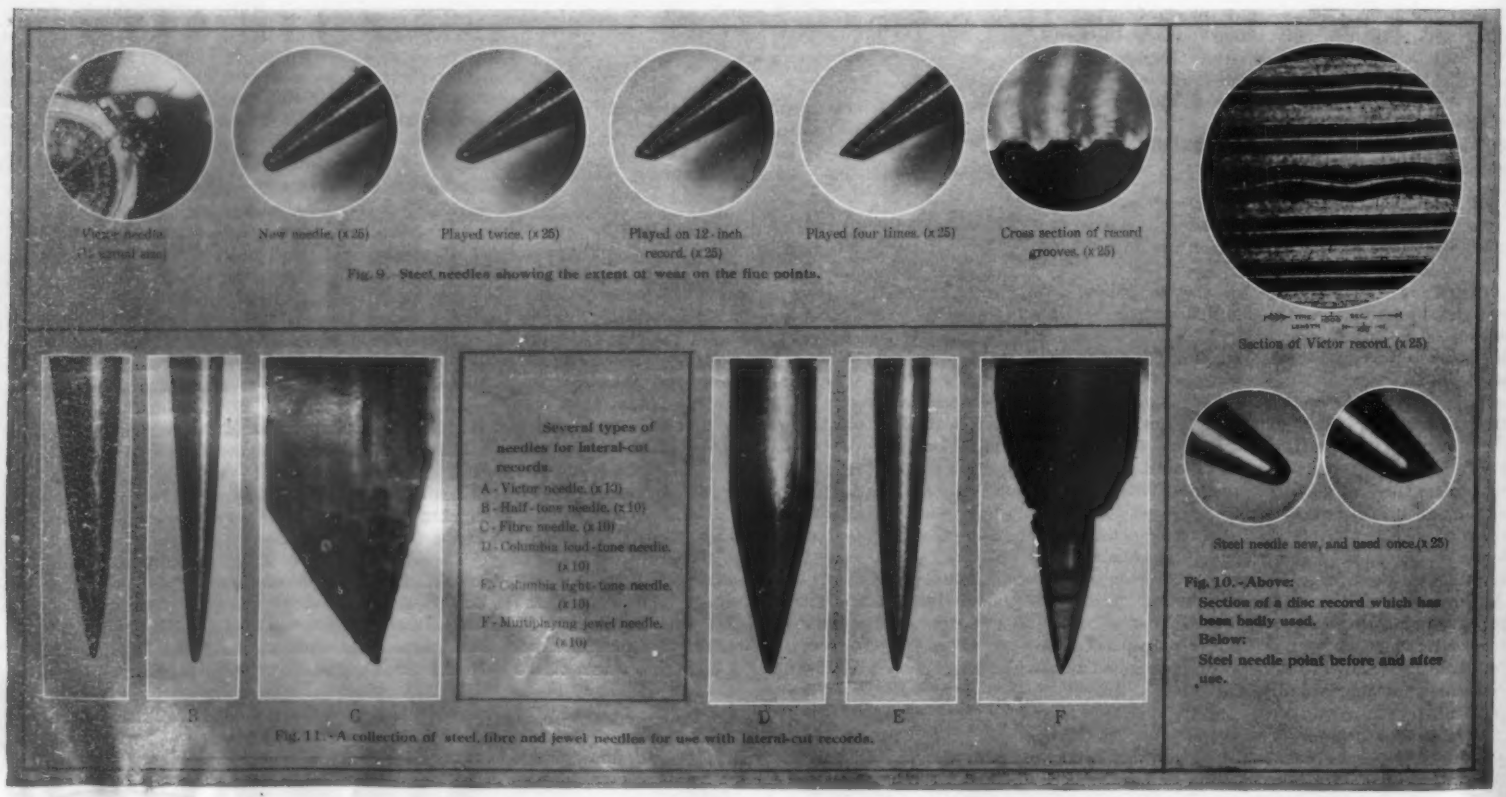
In the early forms of Edison's machine which were exhibited, indentations were made, by means of a steel point on a diaphragm, in a sheet of tin-foil wrapped on a revolving cylinder. The foil served both as original and reproducing record. A piece of tin-foil used at a public demonstration in England in 1878 is shown in Fig. 2.

The tin-foil record soon gave way to hollow wax cylinders in which a helical groove of variable depth was cut. These were slipped over a tapered mandrel. Fig. 3 shows, magnified, the grooves of fluctuating depth of several cylinder records, as well as those of some disc records employing the same type of groove.

In these cylinder records and in some later forms of disc records, the displacement of the stylus which connects with the diaphragm is up-and-down. Many of the well-known disc records have a groove of uniform depth in which a needle or stylus of steel or other metal, or sometimes of fibrous material, rests. Here, instead of by vertical motion, the groove receives the sound record by a lateral or side-to-side motion. Photomicrographs of a number of records of this type are shown in Fig. 7. In this motion these disc records resemble the phonautograph and oscillograph records.

A microscopic study of a phonograph record for sound analyzing purposes is disappointing because the scale of time is so long and the deflections so small, relatively speaking. Compared with an oscillogram, the disc record shown in Fig. 10 is most interesting. In the oscillogram, 1-100 second takes a little more than one inch and the deflections run to one half inch. In the enlarged phonograph record, on the other hand, the time scale for 1-100 second is 16 inches, but the deflections, although magnified 25 diameters,[1] appear

[1] The photographs from which the accompanying illustrations were reproduced were, in most cases, of a magnification of × 20, and in a few cases × 50. Space, however, does not permit the reproduction of the photographs actual size, so the magnification has been altered as indicated.


Victor needle. (⅝ actual size)
New needle. (x25)
Played twice. (x25)
Played on 12-inch record. (x25)
Played four times. (x25)
Cross section of record grooves. (x25)
Fig. 9. Steel needles showing the extent of wear on the fine points.
Several types of needles for lateral-cut records.
A-Victor needle. (x10)
B-Half-tone needle. (x10)
C-Fibre needle. (x10)
D-Columbia loud-tone needle. (x10)
E-Columbia light-tone needle. (x10)
F-Multiplaying jewel needle. (x10)
A
B
C
D
E
F
Fig. 11.-A collection of steel, fibre and jewel needles for use with lateral-cut records.
Section of Victor record. (x25)
Steel needle new, and used once. (x25)
Fig. 10.-Above: Section of a disc record which has been badly used. Below: Steel needle point before and after use.

Collection of various types of steel, fibre and jewel styluses, and the wear to which they are subjected

as only 1-32 inch. With this relationship between time and displacements, the eye is unable to receive any proper impression of the wave shape, hence a replotting similar to the drawing of the profile of a railroad is needed for study. Such transcribed phonograph records have been made by Louis Bevier, Jr., for the vertical cut cylinder,[1] while the lateral cut discs have been studied by E. W. Scripture.[2]

The variable depth of cut is well shown in the photo-micrograph appearing in Fig. 4. This record was broken to illustrate the appearance of the sound grooves in cross-section. The cut and polished spherical sapphire used as reproducing stylus has been placed in position in one of the grooves to show the relative dimensions and the extent of bearing surface. This is a disc record which starts to play from the inner end of the spiral grooves. There is no difficulty experienced with this record in the matter of the feed or self-propelling of the sound-box on the swinging arm across the face of the record, although the shallowness of the grooves, as shown in the cross-section, might lead one to predict trouble. The pitch here is 80 per inch; that is to say, the grooves are 1-80 inch apart.

Fig. 5 shows in similar views the face of a record and a broken cross-section of the disc with the stylus in place. In this make of record the pitch is 150 per inch and the reproducing stylus is a diamond with a rounded end ground to proper radius for the groove. Although the groove is quite as deep as that shown in Fig. 4, the makers furnish a sound-box of a construction requiring a geared mechanism to feed along the reproducing sound-box and the connections to the resonating horn. In the cross-sectional view there is clearly shown the composite structure of the record. As the magnification is eight diameters, surface layer is but little more than 1-100 inch thick and of a material better suited than the base or filling material to mould to the "master" in the process of manufacturing, and to stand the wear of the reproducing stylus.

In the vertical cut or hill-and-dale types of record, the recording stylus—more properly a cutting tool—has a circular cutting edge; the cross-section of the groove being practically the segment of a circle and differing but slightly from the circular curve because the edge of tool, as shown in Fig. 6, works at an angle to the record receiving surface. The circular curve is advantageous because hard substances, such as sapphire and diamond, can be worked and polished readily to any given circular and spherical dimensions. Working to other shapes and curves is more expensive and less exact.

Fig. 6 shows two sizes of recording sapphires and the corresponding spherical reproducing sapphires. The bearing of the sphere in the groove of the record is on a line—that is to say, part of a great circle—so long as the depth of the groove is constant and when the sphere is on the tops of the "hills." When changing grade and when resting on the bottom of the "valleys," the bearing will be on a surface—one or the other or even both sides of the normal bearing line making contact, and if the hills are short and steep, as occur with loud tones of high pitch, the spherical sapphire may bridge parts of the valleys. To reduce this bridging and secure better tone quality without increasing the diameter or the speed of a cylinder record, the button-shaped sapphire illustrated has been used.

The faces of six lateral cut records are shown, magnified 15 diameters, in Fig. 7. Three of these are familiar large sized records, while the remaining three are small sized novelties. The inferior tone of these cheap novelty records is readily understood by comparing the rough edges of the grooves with the clean cut edges of the larger and more expensive records. Furthermore, the smallest of these novelties are physically incapable of rendering the higher frequency musical tones, since the small dimensions make the wave lengths at normal speed comparable with and even less than the bearing length of the recording needle.

The character of the groove in the lateral cut type of record can be made out from Figs. 8 and 10. Fig. 8 shows the face of a record and a broken cross-section with the point of the steel reproducing needle in working position in one of the grooves. This is a make of record which the cross-section proves to be composite. Surface layers of about 1-75 inch in thickness are separated by thin paper from the base or filling.

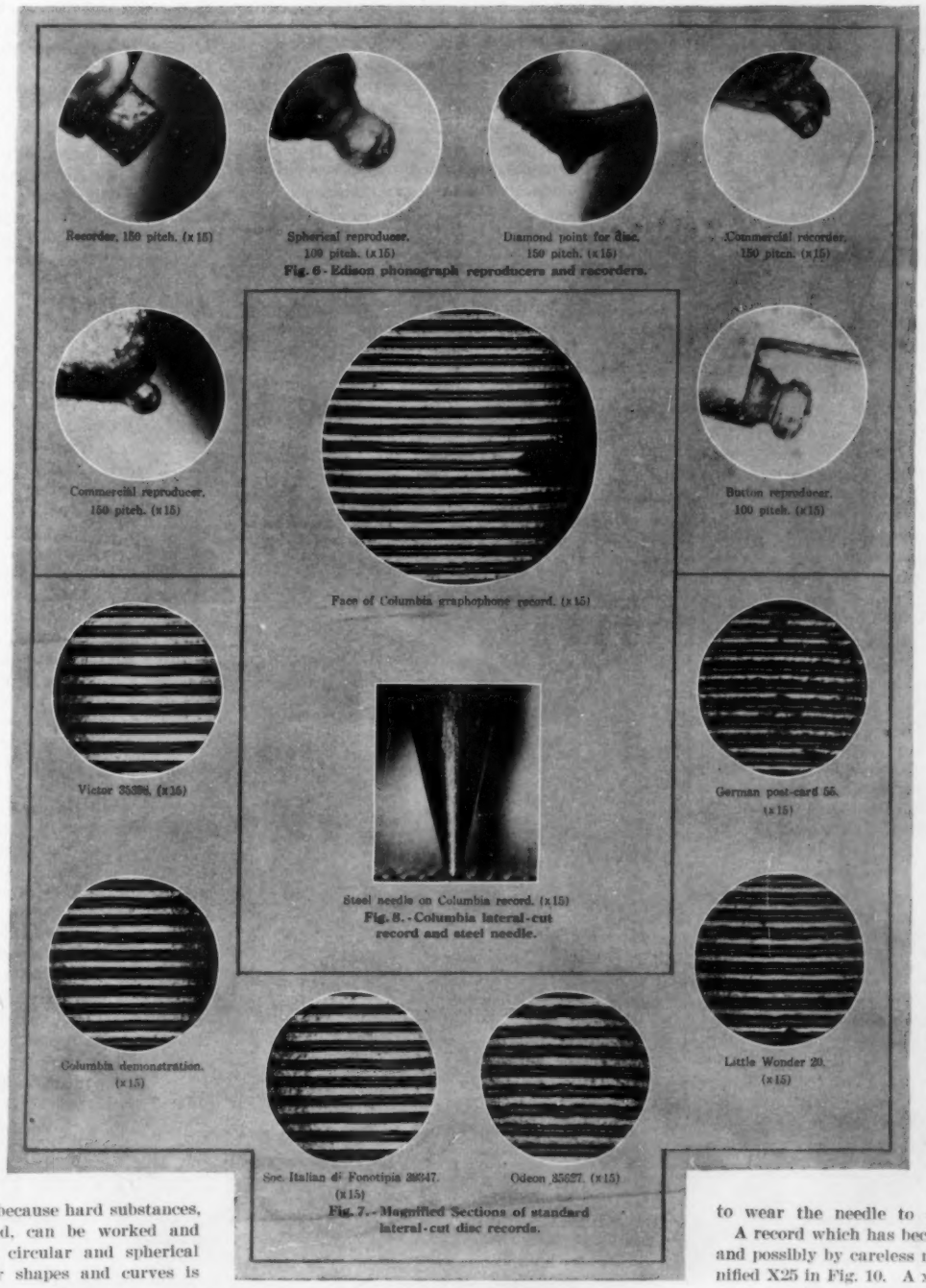

Recorder, 150 pitch. (x15)
Spherical reproducer, 100 pitch. (x15)
Diamond point for disc, 150 pitch. (x15)
Commercial recorder, 150 pitch. (x15)
Commercial reproducer, 150 pitch. (x15)
Button reproducer, 100 pitch. (x15)
Face of Columbia graphophone record. (x15)
Victor 35398. (x15)
German post-card 55. (x15)
Steel needle on Columbia record. (x15)
Columbia demonstration. (x15)
Little Wonder 20. (x15)
Soc. Italian di Fonotipia 28047. (x15)
Odeon 35627. (x15)

Fig. 6.-Edison phonograph reproducers and recorders.

Fig. 8.-Columbia lateral-cut record and steel needle.

Fig. 7.-Magnified Sections of standard lateral-cut disc records.

Lateral cut grooves and up-and-down recorders and reproducers.

The photo-micrographs show that the cross-section of groove is more like the curve of the end of an oval or a parabola than a circle. On loud, high pitched tones, where the frequency may run up to 2,000 or even 3,000 cycles, the needle is deflected from the sides of the groove twice this number of times in every second, and the forces on the needle and the sides of the groove are considerable. A circular groove, unless approaching a semi-circle, would allow the needle to ride over the walls.

The foregoing considerations answer the question: Why cannot non-wearing materials like the diamond and sapphire be properly used on the side-to-side sound-groove type of record? For proper tone rendering, the stylus or needle must fit and fill the slot exactly: if too small, it will be thrown from side to side, giving false tones; if too big, it will give trouble by jamming and causing excessive wear of the record. The impracticability of making records and large numbers of jewels with grooves and points of duplicate and exact curvature and dimensions is practically met by using needles of steel or other material *sufficiently soft* to wear from an approximate to an exact fit in the first few revolutions of playing a piece, and yet *sufficiently hard* to play the whole of one or two records without wearing down to too extensive a shoulder bearing, or too long a base bearing for satisfactory tone rendering.

The narrow white line in the middle of the grooves of the photo-micrographs showing the faces of records may be mistaken as indicating a V-shaped groove with a flat bottom. This line, however, is merely that portion of the curved surface so related to the source of light and to the image forming the objective that light is reflected from one to the other; and photographs can be made of the same record showing this line finer or broader by varying the source of light and working the numerical aperture of the microscope objective. Phonograph records approximate polished surfaces and are black besides, so examination and photographing is not easy since practically all the light returned is by specular reflection.

The wearing of a steel needle is shown in Fig. 9. Here magnification is X25, and side views of a needle show it when new and after playing a 12-inch record once, twice and four times. A few calculations have been made for this test:

Weight on needle end, lb.	¼
Area of needle end (approx. average), sq. in.	1-36000
Weight per square inch, lbs.	9,000
Distance traveled, four records, feet	2,928
Average speed of record under needle, miles per hour	1.82
(2.73 m.p.h. max.—.91 m.p.h. min.)	
Thickness of steel worn off, inch	1-500

For best results, it is obvious that steel needles should be used to play but one record and then discarded. If the needle is not removed from the holder, a second playing of the same piece, as is often done when dancing, may not do serious harm. The unpardonable offense against record property and proper phonograph usage is to place in the holder a needle previously used. The point is then like a graving tool, and its sharp shoulders will almost certainly not be in proper position to fit the groove and will scratch the record badly until the playing has continued long enough to wear the needle to a new full bearing.

A record which has become worn by repeated playing and possibly by careless needle handling is shown magnified X25 in Fig. 10. A xylophone record was searched until a note of high pitch and intensity was located. This note is roughly the high C of the soprano, over 1,000 cycles per second. The sides of the groove, which bear the brunt of deflecting the needle with its attached levers and diaphragm, shows clearly nicks in the edge of the groove. These nicks come alternately on opposite sides of the groove, about 1-100 inch apart and 1-2000 second later.

Several types of needle for lateral cut records are shown enlarged in Fig. 11. There are a large number of forms, types and makes of needles on the market and extravagant claims are made for many of them. Unless the possessor of high priced records knows, as a result of microscopic examination, the shape of the point and the character and extent of its wear, he will do well to avoid all novelties. "Permanent" or "multiplaying" needles in general for lateral cut records should be regarded with suspicion and used with great caution, for while there are types of needles which may not damage a record when used intelligently, the harder a needle and the less the wear, the greater

(*Concluded on page 433*)

[1] Physical Review, April, 1900, *et seq.*
[2] Publication No. 44, Carnegie Institution of Washington, 1906.

Science as an Aid to Practical Tennis

By Dwight Douglass
California Professional Tennis Instructor

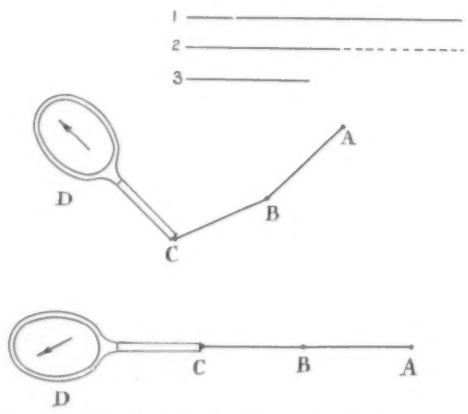
SO scornful of science have tennis players become, as one pet theory after another has proven unpractical, or at least not the cure-all it was supposed to be, that one feels constrained to offer a semi-apology in suggesting that science holds much value to practical tennis players.

Science is merely exact knowledge, and guessing is a poor substitute for knowing. If a method does not work well, and if by science it can be shown that it never can work well, then much time can be saved. But if, on the other hand, two apparently opposed methods work well, that is a most remarkable phenomenon, and worthy of careful investigation. Adherents of each are likely to decry adherents of the other; but why not find out wherein each is good and wherein each is faulty, and then combine the two in a method which keeps the good and discards the bad? Even the most "practical" player would admit the value of science if that could be done. And it has been done in the case of the forehand and background drives. Yet not one tennis player in a hundred knows what has been done, and how he himself may benefit, although the most conspicuous player in the United States to-day has accomplished the feat, and has won the American Championship largely by the aid of drives that combine the good elements of the English method with the good elements of the American, and has simultaneously eliminated the bad in each. He did not start at the scientific end. He adopted these strokes instinctively in the course of much practice. The writer has learned in conversation that he does not understand even to-day the reason his strokes are exceptionally effective. Let us see what he has done.

The English generally hold the head of the racket above the level of the hand. As they also keep the elbow low and hold the racket as one would hold a hatchet, their strokes are more like sidewise waves of the arm than like direct blows such as a baseball batter uses. As the wave is made, the natural inertia of the head of the racket, coupled with the weakness of the wrist in this sidewise position, causes the racket head to trail somewhat back of the hand, so that the ball is met smoothly, without shock, and this enables the ball to roll somewhat along the racket face, and causes the ultimate throw-over of the racket to toss the ball toward the net in one form of the centrifugal curve-throw.

Mechanically this English arm angle is weak, and holding the racket head above the hand causes the ball to roll up-hill, and so gives it under-spin that makes it sail instead of drop. Most Americans prefer to make their strokes with the arm and racket-handle moving in the same general plane, which is, manifestly, very much stronger mechanically. The tendency is much more marked, however, in the American stroke to meet the ball squarely with a shock, which, being concentrated in a smaller period of contact, increases the muscular effort required and decreases the chance of the ball being thrown smoothly from the racket. This smooth throw is a great advantage in decrease of effort and increase of speed, and is undoubtedly responsible for the persistence of the English stroke. So both types of stroke have advantages and disadvantages. Obviously, they should be combined, using the principle of the English stroke, but applying it in the straight American plane of force.

This is precisely what William Johnston has accomplished more conspicuously than other players in his forehand drive. The English slide the ball on at the lower edge of the racket. Johnston slides it on at the inner edge nearest the handle. The English throw the ball off at the top of the racket. Johnston throws it off at the outer edge. The English get very slight force because the turn of the wrist is too weak. Johnston gets very great force because his racket and arm swing in the same plane, and because he pulls directly along his arm with a sidewise lunge, just at the period when the ball is running across the racket. Johnston gets top-spin by tilting the racket forward just before he draws it around directly across in front of his body, finishing the swing far to the left. If he should finish his swing straight ahead instead of across the body, he would probably not be the American champion to-day. His speed would sink to the average level; and he needed all of the remarkable speed he has,



English Bent-Arm and American Straight-Arm Drives

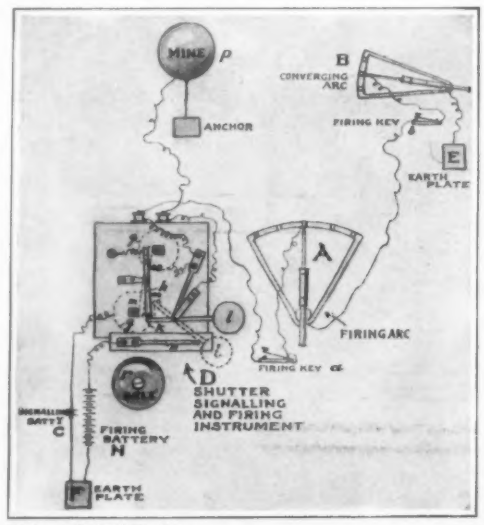
A, Shoulder. *B*, Elbow. *C*, Hand. *D*, Racket head, with arrow indicating general direction of sweep of ball across racket, producing under-spin in English drive and top-spin in American drive. The lines above indicate (1) Racket speed necessary to completely absorb force of fast drive, if hit is instantaneous; (2) speed of racket in average drive, dotted line representing proportion of blow withstood by wrist; (3) racket speed necessary in curve-throw which eliminates shock.

to beat, in four successive days, Behr, Griffin, Williams and McLoughlin. The writer explained the principle of the curve-throw in a previous article. That was a

(*Concluded on page 435*)

Observation Mines for Harbor Protection

WHEN it is necessary to lay mines in channels likely to be used at times by other than enemy vessels, such as home harbor entrances, etc., contact mines cannot be used with safety. These are therefore replaced by observation mines, which, as their name implies, are kept under observation and fired electrically from the shore when any enemy vessel is seen to be passing sufficiently near to the mine to sustain damage from its explosion (Fig. 2). An observation-mine, watched simultaneously by two observers situated some distance apart in suitable positions, may be fired by the operation of their two telescopes, the electric firing-circuit being completed when, and only when, both telescopes point exactly at the position of the mine (Fig. 2), and the two firing-keys, one under the control of each observer, are both pressed down. If, therefore, the two observers keep the victim under continual observation by telescope when passing through the mine-field, and at the same time hold down their firing-keys, no mine will explode unless the vessel passes over it, and the explosion will occur if she does so.



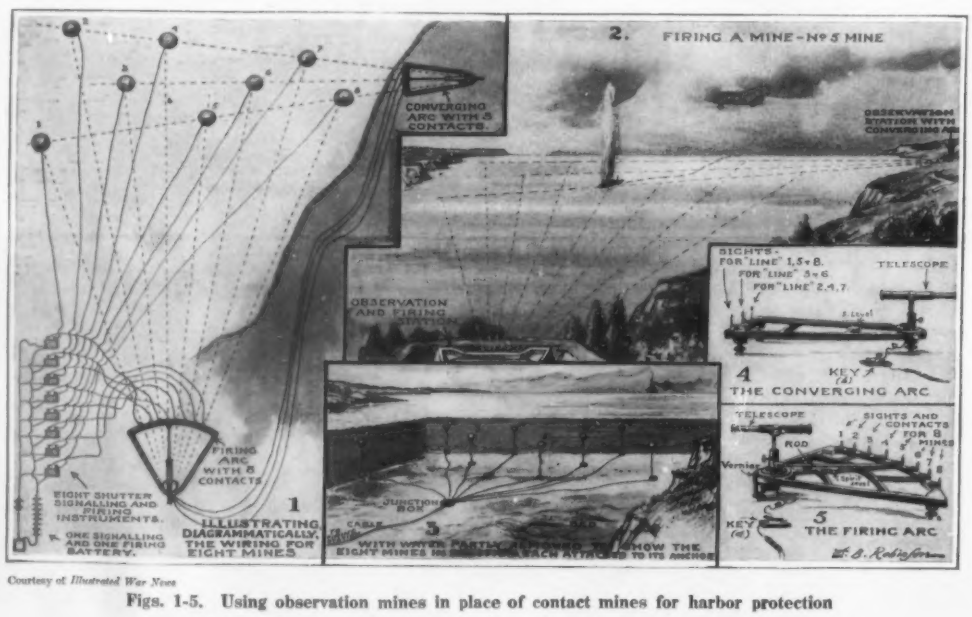
Courtesy of *Illustrated War News*

Fig. 6. Instruments used in firing an observation mine

The observers' positions are called the "firing" station and the "converging" station, the former being usually situated opposite the harbor entrance, its line of sight crossing the lines of mines (Fig. 2); and the latter to one side of the channel, the lines of mines being so laid that they point to, or converge on, the converging station. The firing station is usually a fort, but not necessarily so. This station contains the bulk of the electrical appliances, and, if not sufficiently fortified to be impregnable, should be itself mined, so that the whole thing can be blown up rather than be allowed to fall into the enemy's hands. Both the stations should be built in such a manner as to blend with surrounding objects, and for that reason be as invisible as possible. At the firing station is fixed a telescope mounted on a base plate which takes the form of a quadrant, the complete instrument being termed the "firing arc" (Fig. 5). As the telescope swings round, a rod, rigidly attached to it in a horizontal position, makes contact in turn with a series of insulated plates fixed on the periphery of the quadrant, each of these plates being electrically connected with the particular mine at which the telescope is pointing when the contact is made. This connection is made by way of a shutter signalling and firing instrument, the action of which switches in the current from the firing battery to fire the mine, and at the same time indicates which mine has been fired.

To trace the action of the whole scheme refer to the diagram (Fig. 6) of wiring showing one mine only. The telescopes at the firing and converging stations being both placed so as to bear on the mine to be fired, and therefore making the particular contacts on their peripheries apply to that mine only, when the two firing-keys (*A* and *B*; see also Figs. 5 and 6) are pressed down, the current from a small signalling battery (*C*) passes through the shutter signalling and firing instrument (*D*) to the firing arc at *A*, and thence to the converging arc at *B*, the circuit being completed *via* the earth plates *E* and *F*. The passage of this current through the electro-magnet *g g* attracts the armature *h*, so that it takes up the dotted position, in doing which it releases the detent *k* and allows the disk *l* to fall to its dotted position, making electric contact with the arm *n*. This contact completes the circuit between the firing battery (*N*) and the mine (*p*) by way of the earth-plates *F*. The body of the mine acts then as a second earth-plate, and so fires the mine. The fall of the disk *l* operates a hammer which strikes a signal bell (*r*), and the new position of the disc *l* indicates that the mine controlled by this shutter instrument is fired.

In order to control a number of mines it is necessary to provide a shutter instrument (*D*) for each mine, a firing-arc (*A*) having as many contact-plates as there are mines; a conveying-arc (*B*) having as many contact-plates as there are rows of mines (as in Fig. 1). A single signalling-battery (*C*) and one firing-battery (*N*) will deal with the whole system. When there are three rows of mines, and consequently, three contact-plates on the conveying-arc, three cables become necessary between the firing and conveying arcs. An additional cable is also provided for signalling purposes between the two stations. It may thus be taken that absolute security against an explosion being caused by a friendly vessel colliding with an observation mine by accident, or through the set of a tide-current, can be counted on.—*Illustrated War News.*


2. FIRING A MINE - No 5 MINE
CONVERGING ARC WITH 8 CONTACTS
OBSERVATION STATION WITH CONVERGING ARC
SIGHTS FOR "LINE" 1,5 & 8. FOR "LINE" 3 & 6 FOR "LINE" 2,4,7
TELESCOPE
OBSERVATION AND FIRING
4 KEY (d) THE CONVERGING ARC
TELESCOPE
SIGHTS AND CONTACTS FOR 8 MINES
ROD
Vernier
KEY (d)
5 THE FIRING ARC
FIRING ARC WITH 8 CONTACTS
EIGHT SHUTTER SIGNALLING AND FIRING INSTRUMENTS.
ONE SIGNALLING AND ONE FIRING BATTERY.
1 ILLUSTRATING DIAGRAMMATICALLY THE WIRING FOR EIGHT MINES
JUNCTION BOX
CABLE
3
WITH WIRES PARTIALLY REMOVED TO SHOW THE EIGHT MINES IN
EACH ATTACHED TO ITS ANCHOR

Courtesy of *Illustrated War News*

Figs. 1-5. Using observation mines in place of contact mines for harbor protection

Inventions New and Interesting

Simple Patent Law; Patent Office News; Notes on Trademarks

A Word About Coupon Attorneys or Those of the "No Patent No Pay" Variety

WE are repeatedly asked about the "No Patent No Pay" system adopted by some attorneys, but to give a full explanation of this phrase and what an analysis of its purport demonstrates can scarcely be covered in a brief statement.

In the business world it cannot be expected that work shall be done or services rendered for nothing. Services purporting to be rendered without pay can hardly be of any real value, particularly in the legal or the patent profession.

To the discriminating inventor or, in fact, any reasoning person, giving the matter proper thought, it is plain that the mere securing of a patent is of small consequence if the patent is considered regardless of its scope and of the character of the attorney's work. The competent and conscientious solicitor directs his efforts not to the mere securing of a patent but to the obtaining of a patent containing specifications and claims which recognize what is necessary, in the light of the law and decisions of the courts, to afford proper protection to all the patentable features of the invention.

As is doubtless known it is against the rules of the Patent Office to guarantee the issue of a patent and before an application is filed there is no means of ascertaining positively that a patent will result. Therefore, if an attorney has made a conscientious effort to secure favorable action but has nevertheless failed, is there any reason why he should not receive proper remuneration for his efforts?

The advertising of some attorneys is more adroit than candid and is intended to give the impression to the unwary that *no charge whatever* is made when an application is finally rejected, whereas a certain amount, undoubtedly sufficient to cover the work done, is demanded regardless of the final outcome. Moreover, these attorneys rely on various contingencies prominent among which are,—(1) the careless reading of the supposed contract or agreement by the inventor; (2) the keeping of an application pending for a long time with the knowledge that many inventors will lose interest and not demand a reckoning; (3) the possibility that a very limited claim will be conceded by the Patent Office; (4) in some instances claims are presented on unimportant details not actually submitted by the applicant and not forming a part of his invention.

The real and only security for an inventor resides in the services of a recognized competent and conscientious attorney and he can obtain these services only upon the payment of a reasonable fee. An alleged offer to render services without pay, if failure results, may properly be looked upon with suspicion when offered as an inducement to obtain business.

There is no short road to obtaining patents; there is no way in the commercial world to get something for nothing, and those who try to, invariably find that they have been misled.

Some attorneys almost engulf the inventor with hand books, books on "What to Invent," endorsements of Government officials, coupons, Certificates of Patentability, etc., with a view of making a strong impression. Some attorneys offer to make a free search or issue a Five-Dollar Free Search Coupon. It requires time and money to make a Patent Office search. Any attorney, therefore, who offers to render this service for nothing, does work which is worth that exactly, and no more.

Perhaps one prefers to invest in a "Special Case" Fifteen-Dollar Coupon. This will insure one's application being "taken up out of its turn." For the small sum of $15 one's business is to be given preference over that of other inventors; but the question naturally arises, does one wish to place his business in the hands of attorneys who have their favorites, and who push forward the work of some clients at the expense of that of others?

Or, perhaps one cares to purchase a Certificate of Patentability, with a guarantee that fees will be returned if a patent does not issue. A Certificate of Patentability, although an elaborately engraved document, bearing an impressive seal, is of little value, since it does not guarantee what its name implies. The Certificate of Patentability is sent to an inventor presumably after a search has been made, but this search (?) is generally limited to United States patents, and it is possible that an invention may be anticipated in a foreign patent, a publication, or a pending application, which are not accessible for the purpose of search. How, therefore, will the possession of such a certificate indicate that an application for patent can be successfully prosecuted? As to the contract relative to the return of the fees: What is this contract? Read it and it will be noted that it returns all the fees paid except a few one may not have noticed, such as the first Government fee of $15, an agency fee of $10, and the cost of the Patent Office drawings, which is an indefinite amount to be determined by the attorney while one's application is being prepared. One does not know, therefore, when he employs a "No Patent No Pay" attorney, what he will have to pay for the handling of his patent application.

Another subject which we wish to treat briefly is the practice of some attorneys of inducing inventors to retain them owing to their exceptional facilities of disposing of the patents by putting the clients in touch with manufacturers who are looking for new and useful devices. This is merely a scheme to secure business since it is obvious that *any manufacturer*, no matter in what line, would adopt a meritorious invention only with full knowledge that by so doing the acquisition would be profitable.

The foregoing information is offered with a view of placing an inventor on guard against those who offer alluring inducements to obtain fees, but who in return fail to render services to the inventor which protect his rights.

Giving information by telephone to the man outside the show window

The Talking Show Window

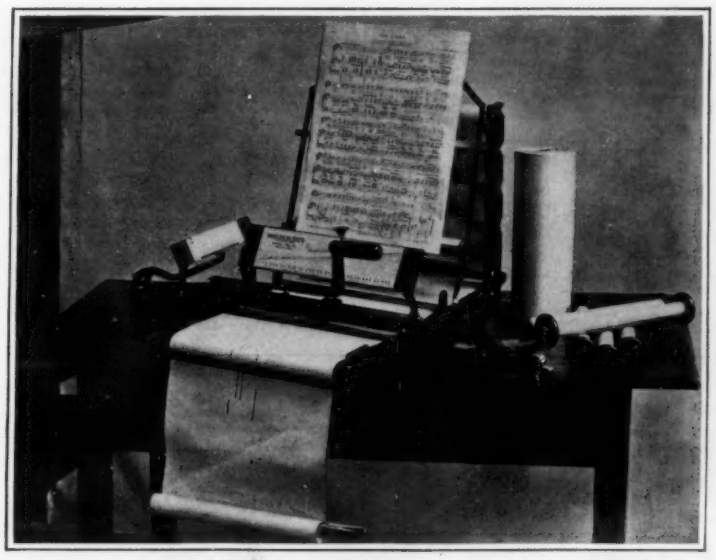
EXPERTS in selling goods to the public often say that if the dealer can succeed in getting people in his store, he will sell goods. That is why so many bargain sales are conducted. People come in for the bargains and they buy other goods as well. Just to try out the psychology of this claim the manager of a store in Newark, N. J., decided to find a way to sell goods and take orders without compelling his customers to enter the store at all.

Usually there are two ways of shopping—either by telephone or going personally to the store. In the latter case the shopper goes to the window and picks up one of several inter-phones extending through to the street side of the window and talks to the clerk who is seated in full view in one corner of the window.

Here is the way the new electrical seller is worked out. The desk of the clerk referred to is equipped with order books, inter-phone and other necessary paraphernalia, and around the clerk, are scattered the goods which the firm desires to call attention to. The passerby stopping to look in the window sees something which interests him, and instead of going inside, he talks to the clerk and asks all necessary questions and perhaps gives an order. The innovation has resulted in increased sales and the addition of many valuable names to the mailing list apart from the advertising value of the new idea.

Machine for Making Player-Piano Rolls at Home

THERE has been recently perfected by an Ohio concern a simple machine that enables any one to make player-piano records at home. Leaving aside the consideration of the expense of manufactured music rolls, the most prominent feature of making one's own rolls is in the pleasure that is afforded in rendering any piece of music selected in a manner that meets individual taste.



Machine for making player-piano records at home. With this model four rolls of paper can be perforated at one time

The machine takes a roll of plain paper of a width corresponding to that of the tracker of the player-piano; the roll being mounted at the back of the mechanism and the paper drawn across the bed plate and dropped in front where it is rolled up as the work of perforation progresses. The punching mechanism is arranged to slide on a bar, alongside a scale that is graduated to correspond with the appertures in the tracker board of the player-piano. At the left is a lever and graduated scale for adjusting the punching mechanism as regards the length of the slots cut, so that the notes recorded will be of the required duration to correspond with the score that is being followed. When the adjustments for position and duration have been made, the punching mechanism is operated, cutting one slot at a time in the paper roll. In order that the paper may be maintained perfectly flat and straight, side guides, rollers and bars are incorporated in the mechanism, insuring the accurate positioning of the slots cut.

It is claimed that player-piano rolls may be made of even the most difficult piece with but a slight knowledge of music, especially after the practice has rendered the operator intimately familiar with the machine and the work. It is not so much a matter of skill as it is a matter of concentration and carefulness, since it is only necessary to glance at one note at a time, adjust the position and time levers accordingly, and perforate the paper roll. Any errors that may be made can be eliminated from the record by covering them over with gummed paper.

The possession of the player-piano roll machine insures plenty of music records for the player-piano at a monetary cost represented by the plain paper only. It would appear that such a machine must needs become a necessary accessory to the automatic piano.

The player-piano roll machine is also furnished to perforate four records at a time, enabling the owner to make extra records which may be exchanged for those made by other persons also possessing such a device, or sold to player-piano owners.

RECENTLY PATENTED INVENTIONS

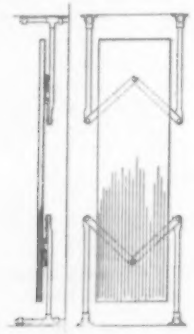
These columns are open to all patentees. The notices are inserted by special arrangement with the inventors. Terms on application to the Advertising Department of the SCIENTIFIC AMERICAN.

Of General Interest

CASE.—F. S. DICKINSON, care of Becton, Dickinson and Co., Rutherford, N. J. This invention relates to metallic shipping and storing vessels, and provides a metallic case or box having a box body and a hinged cover, and more especially designed for holding hypodermic and other syringes and other articles, and arranged to hold the cover against lateral shifting on the box body without the use of special reinforcements, and to provide a locking device for normally holding the cover in locked position on the box body.

CONTAINER.—J. J. FARRAR, Rapid City, S. D. This improvement relates to a manner of packaging cement, lime, plaster and other loose materials that are subject to hard usage in handling and transportation. It includes a novel container for the materials, a method of charging the container, and a novel package formed by means of the container.

EXTENSION SHELVES.—M. J. CASEY, New Richmond, Wis. The invention refers to shelving for the display of merchandise, with a particular reference to shelves adapted for the storage and display of burial caskets, and



EXTENSION SHELVES.

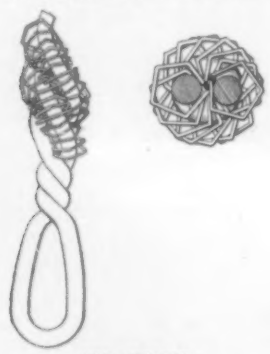
one of the main objects thereof is to provide shelves which may be normally maintained in an out of the way position, as within a cabinet, and which may be withdrawn from said cabinet to permit close inspection of the casket.

WALL BOARD.—P. J. CAREY, 425 W. 44th St., New York, N. Y. This wall board may be readily worked with tools, it being possible to cut the board to fit, and join the parts as may be desired. The board may be planed, sawed or worked with a chisel or other tools and the cuts in all cases will be sharp, so that close joints may be made. The board is constructed so that the parts may be effectively mortised in a variety of ways.

Hardware and Tools

COMBINATION PAPER HANGING TOOL.—J. H. KANE, 806 Westside Ave., Jersey City, N. J. This invention has reference to improvements in paper tools, and particularly to a paper hanger's tool, and has for its object to provide an improved construction which may be used to accomplish a plurality of results upon the operation of a single handle.

GUN CLEANER.—J. HAVLICEK and J. B. SCULLANE, 60 Bedford St., Springfield, Mass. The invention relates more particularly to all-metal attachments for effectively cleaning the barrels of rifles and guns of various bores, the object being to provide a simple, strong and durable implement, attachable either to a

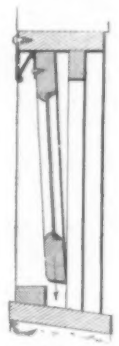


GUN CLEANER.

cord or rod for passing the same through the barrel of a gun, and provided with all metal cleaning or scouring elements with means for holding and carrying a fabric whereby the barrel of the gun may be wiped following the cleaning members.

PNEUMATIC HAMMER.—M. SHANER, 28 North High St., Bethlehem, Pa. This invention provides a device wherein a rapidly reciprocating element is controlled by means of a valve actuated by said element, which may not only be used for tools, but may serve as an engine, or for rapidly striking a gong on cars provided with a compressed air tank to serve as an alarm, thus avoiding the banging of a foot down on the present gong, as merely a push button would suffice.

HINGE.—W. C. RAMSEY, Peculiar, Mo. This improvement relates to hinges for windows and more particularly to that class of windows employed in cellars, basements and the like. An object is the provision of a suitable hinge



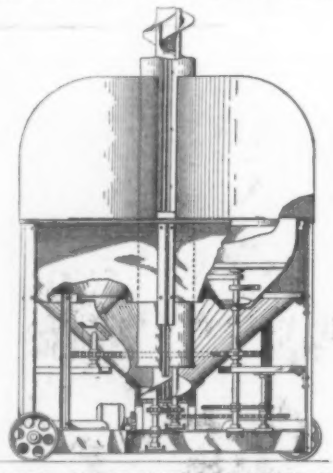
WINDOW HINGE.

connection between the sash frame and sash for effecting a lateral movement of the latter when being opened and closed, whereby friction between said sash and the molding therefor is reduced to a minimum.

DIE HOLDER.—J. M. CARPENTER, care of Carpenter Tap and Die Co., 17 Newall Ave., Pawtucket, R. I. This invention relates to improvements in die holders, and has for an object the provision of an improved construction and arrangement which will hold a spring or pronged die in working position without causing or allowing any distortion of the prongs.

Machines and Mechanical Devices

MACHINE FOR ELEVATING AND MIXING CONCRETE.—A. W. ALTHOFF, 217 W. 2nd St., Oklahoma City, Okla. This invention has for its object certain new and useful improvements in machines for elevating and mixing concrete. Whereas in the existing methods of erecting a concrete building the water, sand, cement, crushed stone and other materials used in the concrete are mixed together at a lower part of the building or on the ground and then hoisted upward to be poured into



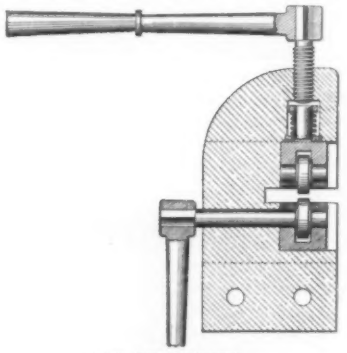
MACHINE FOR ELEVATING AND MIXING CONCRETE.

the forms, often allowing a sufficient length of time to expire to give the concrete an opportunity of hardening or "setting" before reaching the forms, the invention presents a machine for mixing the ingredients of the concrete as well as for delivering the batch to the upper floors by means of a vertical, spiral-drive conveyor. Another object of the invention is to provide means for more thoroughly mixing the materials entering into the concrete mixture.

LOCK FOR GRAVE VAULTS.—M. E. COBB, Marion, Ohio. This invention relates to locks for grave vaults and more particularly to that type of lock which, when in its locked position, cannot be released from the outside of the vault. The object is to provide a lock of this kind which will serve not only to lock the closure in its closed position but to draw the closure very tightly against its seat, thus effectually sealing the closure against the entrance of air or moisture; and further, to so construct the locking mechanism that the pressure on all parts of the door will be inward. It is also an object to so construct the locking mechanism that by the release of a detent, before the closure is locked, the locking devices may be manipulated from the exterior of the door to release the same, thus permitting the vault to be used as a shipping case. A further object is to provide a device of this kind which will be very simple in its construction and positive in its operation and which will be of such a character that the mechanism will not be easily disarranged or rendered inoperative; and further, to so arrange the locking mechanism that an excess of movement of the operating device for the locking members will not relieve the pressure on the closure.

LINOTYPE MACHINE.—J. WEISSINGER, 1227 53rd St., Brooklyn, N. Y., N. Y. This improvement refers to linotype machines, particularly to the matrices used therein, and the main object is to provide means for cleansing said matrices of dirt or corrosion automatically, whereby the characters therein are rendered clearly visible to the operator in the position of the first elevator.

SAW RIM ADJUSTER.—N. H. STONE, Box 22, Garyville, La. This invention has particular reference to means for treating band or circular saws to prevent damage thereto such as buckling or cracking along their backs or along the throats of their teeth. It therefore provides a device for operation upon saws for the purposes above set forth, and also under certain conditions to be employed as means for setting the teeth of a saw, either separately or in conjunction with the saw straightening means.



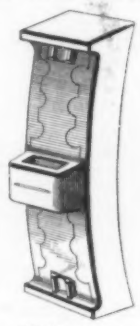
SAW RIM ADJUSTER.

TUMBLER FOR COMBINATION LOCKS.—N. S.-G. BESHAROV, 850 Main St., Paterson, N. J. The invention relates to improvements in combination locks of the type disclosed in United States Letters Patent No. 1,046,253, granted to Mr. Besharov, and the invention has to deal more particularly with improvements in the construction of the tumblers for such combination locks. The general objects are to improve and simplify the construction of the tumblers for combination locks so as to be more reliable and efficient in operation and expeditiously manufactured and assembled.

SEWING MACHINE.—THEKLA TROTT, Berlin, Germany. In existing systems in order to use the sewing machine for darning, accessories are required, which are mostly not at hand, and, in any case, take some time to attach. Further, in such devices, the vertical restriction of the fabric is not sufficient, so that the thread is easily broken, and good darning requires, at the least, extreme skill on the part of the operator. According to the present patent these drawbacks are removed.

Railways and Their Accessories

BRAKE SHOE.—CHILTON WITHERS BLUE, Montgomery, Ala. This invention is in the form of an improvement in that type of brake shoes for railway rolling stock in which a body



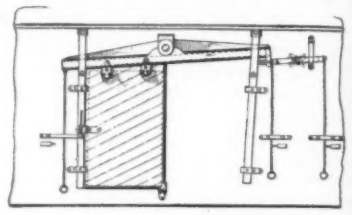
BRAKE SHOE.

or wear portion is cast upon a comparatively thin back formed of steel or other wrought metal, and serving as a reinforcement for the body. The invention relates to the particular construction of the reinforcement and its connection with the wear block or brake shoe in such manner that it cannot become disconnected from the latter.

COMBINED RAIL BRACE AND TIE PLATE.—J. O. PHELPS, 633 Warren St., Brooklyn, N. Y., N. Y. The invention provides a combined rail brace and tie plate which is simple and durable in construction and arranged to permit of conveniently placing the rail in position on the tie plate and then fastening the rail securely in place and bracing the same against spreading.

MINE CAR BRAKE.—H. D. SCOTT, Kool, Wyoming. This invention has particular reference to that class of devices shown and claimed in Letters Patent of the U. S., issued to R. McClaskey, on November 25, 1913, No. 1,079,570, and since duly assigned to him. The present invention improves that class of brakes adapted especially for mine cars whereby they are rendered more effective and serviceable than previous devices.

CAR DOOR OPERATING MECHANISM.—W. E. HARRIS, Lebanon, Mo. The inventor's object is to provide mechanism especially adapted to operate that type of door which moves over and away from the door opening



CAR DOOR OPERATING MECHANISM.

by gravity, the said door being mounted on a track bar which is pivoted to the car at the door opening and the invention provides an improved form of operating mechanism for swinging the track bar.

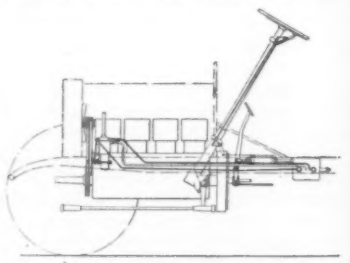
COUNTERBALANCING DEVICE.—J. J. STRONG, 4638 1st Ave., Birmingham, Ala. This invention is an improvement in counterbalances for locomotive gear, and has for its object to provide mechanism for use in connection with the reverse mechanism of a locomotive for counterbalancing the said reversing mechanism to make the operation less difficult.

PIPE COUPLING DEVICE FOR RAILWAY AND TRAM CARS.—L. BOIRAULT, 58 Rue Taitbout, Paris, France. This invention relates to pipe coupling devices for railway and tram cars and has for its object to so construct a device of this character that it will permit of air, steam, gas and other similar fluid pipes being brought into operative engagement with each other by simply coupling the cars together.

Pertaining to Vehicles

LIQUID STRAINER.—A. W. KLEMT, 1200 Lind Ave., Bronx, N. Y., N. Y. The object of this invention is to provide a simple, convenient and strong strainer which is removable from the tank through the top thereof and which strainer is associated with a cup located at the bottom of the tank and which cup forms a water-trap. The invention refers more particularly to strainers for gasoline tanks for automobiles.

AUTOMATIC CONTROL FOR AUTOMOBILES.—J. J. CURRY, 406 W. 56th St., New York, N. Y. This invention relates to improvements in automatic controlling devices for automobiles, and has for an object to provide an improved construction which will throw



AUTOMATIC CONTROL FOR AUTOMOBILES.

out the clutch and apply the brakes whenever the operator removes his hands from the steering wheel. It provides a construction which may be operated at any time by the feet or may be operated at any time by the hand so as to throw out the clutch and apply the brake at any time.

LUBRICATOR FOR LEAF SPRINGS.—P. E. ERICKSON, Port Chester, N. Y. The inventor provides a device for lubricating leaf springs of automobiles and other vehicles to prevent such springs from squeaking and to reduce the wear thereof to a minimum. To accomplish this, use is made of means for prying adjacent leaves apart and passing a lubricant between the pried-open leaves.

LICENSE TAG BRACKET.—M. HOLLAND, 89 W. Botolph St., Boston, Mass. The invention relates more particularly to brackets designed for holding license tags for automobiles. It provides a bracket which will be extremely simple in its structure, which may be easily attached without the use of special tools, and which may be secured in place without alteration of any of the machine parts.

EXTENSION ARM.—R. F. GROUT, Derby, Vt. The object here is to provide an extension arm arranged to permit the driver of the automobile to conveniently reach and manipulate the hand lever without bending down as is now required and practised, which action is especially inconvenient for women and portly persons.

NOTE.—Copies of any of these patents will be furnished by the SCIENTIFIC AMERICAN for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.

The Dyestuff Famine.—II

(*Continued from page 427.*)

A movement in this direction has been recently outlined by Mr. I. F. Stone, in the proposal to establish government-owned factories for the production of coal-tar intermediates. The various admirable features of the plan, including the well-organized preparedness for the speedy manufacture of explosives and munitions generally, in case the nation be menaced by invasion, render the project worthy of the most careful study.

Standardization of Dyestuffs and of the Methods of Their Application

A very distinct element of protection to a growing domestic color industry would undoubtedly result from the establishment of a Bureau of Standards for Dyestuffs. Such a bureau could be modeled after the admirable Division of Chemistry in the well-organized Bureau of Standards, of the Department of Commerce. Its function would be to formulate the physical and chemical criteria of purity for all dyestuffs, exactly as is now done for the drugs listed in our pharmacopeia. In the laboratories of such a bureau,—and they would necessarily be vast,—it must be as easy and simple to check and control the tinctorial values of dyestuffs as we now do for our medicinals.

Such principles of standardization would likewise be applied to the varied methods of application on the different fibres and other wares. A single, finely-equipped bureau could advantageously replace the multitude of laboratories now maintained by rival firms or in textile works. Such an institution could effectively protect a half-grown American industry against attempts to depreciate the quality and value of American-made dyes, and could insure a far greater degree of economy in cost of production than otherwise would be possible.

Everyone, familiar at all with the employment of colors in dyeing, can easily picture to himself the enormous advantages resulting from the impartial and exact classification and standardization of all coloring materials encountered in commerce, or the simplification, economy and certainty attendant upon their use in connection with all fibres and fabrics, as well as with leather, feathers, ink, paper, etc.

Instead of hundreds and thousands of isolated, blundering attempts to obtain the best dye for securing certain color results, the desired data could be requested by return mail from a national laboratory. If a dyer wishes to know exactly under what conditions, and in what quantities, a given dye should be employed to produce certain tinctorial effects upon a specific fibre, with a minimum expenditure of color, the full directions could be obtained, free of cost, with but little loss of time.

Organization of Consumers

Logically, the complete standardization of existing dyestuffs, and of all additions to their numbers, as well as of the methods by which they can be most effectively and advantageously employed, should be a prelude to a vastly simpler and more economical method of merchandizing than is now the rule.

In possession of such a completely organized mechanism for saving time and effort in securing his current supply of colors, the dyer may naturally inquire: Why is it necessary to support a battalion of salesmen and middlemen, each seeking to disparage the quality of his rival's wares?

Here, we are touching upon a field of economic activity, in which more than one experiment has indicated the practical value of collective buying and selling.

When hundreds of thousands of American farmers are able to purchase, at the lowest possible rates, their agricultural machinery, their binder twine, and numerous other articles of daily use in a country home, why should not tens of thousands of consumers of colors utilize the same methods for covering their needs, at a minimum of outlay and a maximum of certainty as to strength and quality?

It would not be a difficult matter to organize into a compact body the consumers of colors, of all forms. Such a corporation would have for its object the purchase in quantities, at lowest wholesale rates, of all required dyes, and the distribution of such wares at cost price to the individual members. The actual expense to each member of such an organization would be almost negligible. Constituent members would be free to buy any dyes in current use. The only restriction would be the absolute requirement that all purchases of colors should be made through a central agency, or one of its branches.

Such an agency would be backed up by the National Bureau of Dyestuff Standards in all current questions regarding purity, ease of application, etc. It would ensure the delivery to members, of dyestuffs of standardized strength and purity, at wholesale rates.

It can readily be appreciated to what an extent consumers of colors would be freed from all uncertainty and anxiety, regarding the price and character of their dyes. It can also be easily seen that a powerful weapon is put into the hands of those who collectively represent the consumers of colors, to rigidly rule out from the sources of supply any manufacturer, foreign or domestic, who would deliberately make an attempt to undersell his American rivals, or who would resort to any other method of unfair restriction of trade.

I hardly need to dwell upon the far-reaching effects of any such organization in protecting, to the utmost, the recognized rights of American producers and consumers of colors, and in providing the machinery for distribution at a minimum of expense. It would be one of the most powerful bulwarks to ward off the dangers of persistent and determined efforts, on the part of European rivals, to crush and stifle an American dyestuff industry.

And such an industry we are bound to have! Our textile and other allied interests resolutely demand that they shall never again be exposed to the disasters accompanying such a dyestuff famine as we now face. Such a powerful national organization as the Association of Hosiery Manufacturers unanimously resolved that it would willingly bear the burden of increased tariff duties on dyes of foreign origin, if that be necessary, to insure the establishment upon American soil of a domestic, self-contained industry.

American chemists insist that the one great branch of color chemistry, now lacking in the cycle of our national industries, should be established in all its ramifications upon our soil, and that American chemical technology should no longer be so conspicuously lacking in the most brilliant feature of applied science.

Before the advent of this deplorable war, we imported annually about 2,500 short tons of aniline oil and aniline salts. In 1916, over 5,000 tons will be manufactured on American soil, from American coal-tar crudes. In 1913, our American color works produced 3,000 short tons of coal-tar colors, made chiefly from German intermediates. We imported 25,600 tons of these colors, of which 22,000 tons came from Germany.

To-day we are making nearly 9,000 tons of these colors. January, 1917, should see an American production of at least 16,000 tons. Am I too optimistic in confidently looking forward to the year 1920 as a date, when the great bulk of artificial dyes, consumed in this country, will be made in American works, from American raw material, by American labor?

Microscopic Study of the Phonograph

(*Concluded from page 429.*)

the damage to the record if the needle is removed from the holder and replaced in a different position. At *F*, Fig. 11, is shown a multiplaying needle formed from a hard jewel, which is offered to the public as solving the needle problem. If the form of the point of this needle is traced on a piece of paper and this cut out carefully and placed in one of the grooves of the record shown in Fig. 8—the scale of magnification being near enough—it may be seen that it does not fit the groove but bears wholly on the sharp point which rests on the bottom of the groove.

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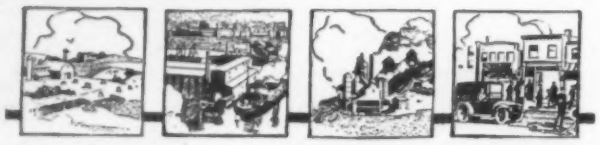

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The purchaser of this needle is instructed to give it a third of a turn after several weeks' playing. The leading point and straight edges made by that time will then be in position to make themselves heard—if not seen through lack of a microscope.

Detecting Buried Shells with Induction Balance

(*Concluded from page* 425)

so that the trained ear easily distinguishes between the two.

In the shell-detecting instrument the distances from the coils to the object sought are much greater than those in preceding applications of the Hughes balance. Therefore, two coils of large diameter are employed; the device being in reality two induction balances used as one. In the three instruments thus far constructed in France, the diameter of the coils is 70 centimeters (about 28 inches). The winding of the primary circuit consists of twenty layers, while that of the secondary circuit has ten layers. These windings are placed on wooden spools of a size not unlike that of the frames of ordinary sieves. The rigidity of the spools is improved by the use of two diametrical reinforcing braces or cross-rods. As is well known to those familiar with the principle of the induction balance, no metal parts of any kind can enter into the construction of the device.

The two windings of the same coil are placed one beside the other at a distance of about one centimeter apart, so that the mutual induction of the primary and secondary circuits will be brought to the neutral state, resulting in the telephone receivers remaining silent in the absence of any metallic mass in the vicinity of the device. The turns of the outer layer are then secured in place on the coil with a suitable varnish and protected by a covering of strong cloth ribbon.

In order to secure precise regulation before making use of the apparatus, a small coil, having only four layers, has been added to each of the primary and secondary circuits; one of these coils, having a diameter a little less than that of the other, being capable of rotation inside of the latter. This rotation, which is on an axis common to both coils, modifies the mutual induction of the two circuits and so permits of delicate regulation at the moment the device is to be employed.

The number of layers used for the windings of the balance has been determined by patient experiment. It was made as small as possible in order that the telephone might be readily brought to a state of silence. The desirable sensibility has been obtained by the use of suitable telephones and particularly by utilizing periodic currents of the most fitting form in the primary circuit. Because of the slight resistance of the balance, the bobbins of the telephone receivers have relatively large wire. The two receivers of the head piece are connected in parallel, and the thickness of the diaphragm of each receiver has been reduced to about one half that of conventional instruments.

The primary periodic current is produced by four dry cells and an electromagnetic vibrator interrupter of a design similar to those employed on medical coils. The vibrating spring of the interrupter carries a silver contact which operates in conjunction with another silver contact mounted on a heavy brass strip; a set screw being provided to press against the brass strip in order that the stationary contact can be adjusted in relation to the vibrating one. By proper adjustment the most suitable form of periodic current can be readily obtained.

Since the electro-magnet of the interrupter is connected in parallel with the primary circuit which contains a condenser of a capacity of six microfarads, the circuit is not traversed by the interrupted current of the vibrator as in the Hughes balance. Instead, the electromotive forces of self-induction in the electro-magnet charge and discharge the condenser that is connected across the primary winding of the balance, periodically.

The arrangement just mentioned permits of a more facile regulation of the instrument and greater sensibility. Experience has indicated that within large limits the sensibility of the device depends on the vibrator, which should produce a sharp, musical sound in the receivers and possess a very small amplitude of oscillation. To bring the balance to the proper state of sensibility, the regulating apparatus is slightly deranged and the vibrator modified until the piercing sound has the greatest intensity attainable. A key or a pocket knife brought near the center of one of the coils ought then to provoke the hearing of an easily perceptible sound.

To explore the desired territory, the two coils—each of which comprises a primary and secondary winding—are placed on two vertical sticks attached to the ends of a horizontal piece of bamboo. An assistant carries the device by means of a suitable handle, and walks over the field to be explored, holding the coils of the balance a few centimeters above the ground. The observer, wearing a telephone head piece and carrying about a box which contains the battery, condenser, vibrator and regulating apparatus, follows at a distance of several feet behind the assistant; a flexible conducting cable being employed to connect the exploring coils with the apparatus of the observer.

Fragments of shells or tin cans or boxes, on or near the surface, produce a sound as intense as that made by a deeply buried shell, but it is easy to distinguish between the two. A superficial object exerts the greatest influence on the device when it is near the edges of the exploring coils. Accordingly, during passage above such an object the observer hears two consecutive reinforcements of the sound. A projectile deeply buried, on the contrary, exerts its maximum action when it is under the center of either coil, and gives only one reinforcement of the sound during the passage of the instrument.

Each coil of the instruments that have been already constructed explores a strip equal to its width; therefore, two strips, each 70 centimeters wide, are examined during each passage. Consequently, it requires about three hours for two persons accustomed to the work to explore one hectar (about two and one half acres) of land.

Twin-Six Engines for Aeroplanes

(*Concluded from page* 421.)

motor of smaller size, one of them being used in the flying feats of "Art" Smith at the Panama-Pacific International Exposition. The big motor turns over at 1,800 revolutions per minute and weighs about four pounds to the horse-power. Besides possessing the advantages claimed for other twelve-cylinder engines, this machine is designed to achieve unusual rapidity in cooling. Other features of the engine are the detachability of the double magnetos, oil and water pumps in one piece with their housing. The propeller end is detachable in the same way.

A twelve-cylinder water-cooled "V" type engine has been brought out by L. E. Rausenberger during the last year. This engine is designed to give 150 horse-power at a normal speed of 1,200 revolutions per minute. The cylinders are staggered, which construction makes it possible to place the connecting rods of opposite cylinders side by side on the same crank pin. The engine weighs 720 pounds.

The Ashmusen 105 horse-power engine presents a worthy attempt to solve the problem of the big motor with the aid of an air-cooling system, and is now in process of perfection at the plant of the builder. Its cylinders will be horizontally opposed, and its weight is given as 345 pounds. The bore and stroke are 3.75 and 4.5 inches, respectively.

Aside from the engines already mentioned, there is a twelve-cylinder engine of the Johnson two-cycle type announced. This engine is of the 90-deg. "V" form, as are the smaller engines of the same make. It has a bore of five inches and a stroke of four inches, with a rating of 150 to 180 horse-power at a speed ranging from 1,150 to 1,400 revolutions per minute. The weight of the engine is 598 pounds.

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The keen interest in better aeroplane engines is not confined to the European countries now at war, for in the United States there has been considerable activity in the matter of encouraging the development of heavier-than-air craft engines, in the recent past.

At the urgent request of the Army and Navy Departments, much attention is being given to engine problems by various aeronautical boards and organizations. Prof. Charles Edward Luckey, of Columbia University, who is investigating the aeroplane engine situation for the National Aeronautic Advisory Board, attended a recent meeting of the Aeronautical Society, which opened a series of discussions on the requirements of present-day aeroplane engines, as well as on the deficiencies of many of the existing types. Two of the new American twelve-cylinder engines, the Aeromarine and Rausenberger, were described at the meeting and aroused much interest. Unfortunately, the designers were too preoccupied to be present and answer questions. At the meeting, Prof. Luckey advanced a strong plea for the standardization of aeroplane engines.

It is believed among aeronautical men that should a contest for aeroplane motors be held by the Navy, in the near future, as has been recommended, the probabilities are that more than one of the "twin-six" types will be found among those seeking the honors.

Science as an Aid to Practical Tennis

(Continued from page 430.)

scientific statement of fact. Johnston is living evidence that science and practical tennis may be in close accord.

There are, of course, limits beyond which science may not help the player. We are obliged to compromise continually with the ideal; but that is no excuse for ignoring mechanical science altogether.

Take the law of the lever, for instance, and apply it in the backhand grip. The thumb straight along behind the handle is supposed to act as an additional support and to strengthen the direct blow. It does not. It weakens it. The law of the lever offsets the apparent increase of strength, and the maximum force applicable with the thumb along the handle is 19 per cent less than with the thumb diagonally or straight around in a grasping position. This is the average obtained in a great many actual tests. The thumb is stiff, and as the force applied becomes greater, the base of the thumb is lifted off the handle, throwing all of the thumb-pressure out to the end. The leverage here is so much more than at the base of the thumb that it is not possible for the normal man to exert as great pressure with the thumb along the handle as with the thumb grasping it and thus bringing the more muscular base into play.

Then, take the mechanical formula that the force of a blow equals half the mass multiplied by the square of the velocity. The faster the ball, the harder it hits, of course, but few realize that an increase of only one half in speed will more than double the force of the blow. This applies equally to the swing of the racket, so that if we can double the speed of the swing we get four times the force in the blow—not merely twice the force. So it is plain that, as we rotate the body, we may get much more force in the blow by keeping the racket away from the body, so that it swings in a larger circle and so travels faster.

But science again steps in and warns us of the limit to which this swing may be carried, and shows the difficulty of swinging the 14-ounce racket fast enough to equal the force of the mile-a-minute ball. It would have to swing at about the rate of 40 feet a second to absorb all the shock itself. Otherwise, the hand and arm must supply a large part of the rigidity at the instant of contact. Forty feet a second is beyond the power of the average player, so the shock on the hand is great and requires a rigid arm to withstand. A rigid muscle moves jerkily, tending to make the shot wild; and the only benefit one derives from a wild shot is the unselfish satisfaction of presenting the point to one's opponent.

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(13089) F. W. W. asks: Can the sun be seen in a direction that is northwest from here? Will you kindly answer this question for me? A. The sun cannot reach the northwest point of your horizon as seen from your place. On the 21st of June it sets the farthest north and then it will be about 32° north of the western point of your horizon at its setting. The northwest point of your horizon is 45 degrees north of the west point, so that the sun is quite a distance from the northwest in June when it is furthest north.

(13090) J. F. B. asks: Is it possible for an irresistible force to meet an immovable body? A. As a logical quibble it is possible to conceive of an irresistible force and of an immovable body, but only as a logical conception. No such force or body exists anywhere in nature. Both of these must be infinite in quantity to be irresistible and immovable. Anything less could be overcome. Thus we reach the inference as a logical conclusion that such a combination is a physical impossibility.

(13091) A. M. L. asks: Is there any known material that will insulate a permanent magnet? In other words, can magnetism be insulated in the sense that we insulate electricity? Can I place a permanent magnet in a box of any material that when closed would so insulate the magnet that its presence could not be detected by a compass, or by any ordinary test? A. A magnet may be insulated by placing it in a box of heavy iron plate. Probably the plate should be a half inch at least in thickness. There is no other substance known which can cut off lines of magnetic force, and iron does it by affording an easier path for the lines than other materials furnish. Of course a magnet thus enclosed cannot be used for any work.

(13092) C. T. J. asks: Please advise if, in your opinion, it is possible to surface cast malleable iron with glass, or some semi-insulating material for low voltage circuits. The insulating material would be required to stand considerable jar and strain. Also advise if you have any books treating on fusing of glass with metals, or how glass may be rendered soft and pliable, so that in case it is impracticable to fuse the insulator to the surface of an iron, the pliable glass may be interposed in sheets to act as an insulator. A. Glass cannot be fused to metals, excepting only platinum. Its expansion with heat is different from that of all other metals and it soon cracks off from the metal. There is no way known to make glass pliable.

(13093) B. F. T. asks: 1. Some time ago an article was printed in your magazine in regard to some kind of plate to use in a kettle of any size for cleaning silver. I cut out the article, but have misplaced it. Can you give me more information about it—whether you recommend its use—where to purchase it, the price, etc? Also what kind of vessel you recommend for use in connection with it? 2. Can the kettle used in this plate be used for other purposes, or is it best to restrict it to the one use? A. 1. The plate to be used for cleaning silver is sheet aluminum, which can be procured from any dealer in metals. The kettle must not be of metal, unless enameled, so that no other metal shall come into contact with the silver, excepting the aluminum. 2. The kettle can be used for other purposes after thorough washing.

(13094) R. G. asks: If I suspend a certain heavy object on a spring scale exactly on the equator, the indicated weight will show the difference between the force of attraction and the centrifugal power of our globe. The same scale with the same object brought to one of the poles, the attraction towards the centre of the earth—now not being counteracted by the centrifugal power which on the poles is equal to zero—will cause a stronger declination on the scale. A different weight ought to be obtained also if the experiment, for reasons of convenience, is made between two points not so far apart north and south as those above mentioned. A. You are quite right in your statement that a body, when weighed with a spring balance, will weigh more at the poles of the earth than at the equator, because of the absence of centrifugal force at the poles. This force is 1/289 of the weight. It will weigh more at the poles because it is nearer the centre of the earth at the poles. At points intermediate between the equator and the poles it will weigh more than at the equator, the weight increasing as the body is carried away from the equator.

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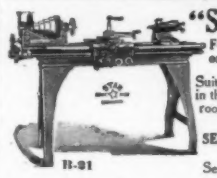

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